WEST SISTER ISLAND WILDERNESS

National Wildlife Refuge System

REPORT ON WILDERNESS CHARACTER MONITORING

West Sister Island, ©Sharon Cummings

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Contents

INTRODUCTION

This report provides a detailed summary of the baseline wilderness assessment completed for the West Sister Island Wilderness within the West Sister Island National Wildlife Refuge (NWR). The Wilderness Character Monitoring national strategy applied throughout this process was developed by an interagency wilderness team, representing the U.S. Fish and Wildlife Service, National Park Service, U.S. Forest Service, and Bureau of Land Management. The national framework strategy identifies the wilderness character qualities: "untrammeled", "natural", "undeveloped", "solitude or primitive and unconfined recreation", and "other features", based on the statutory language of the 1964 Wilderness Act (Act). This strategy is described in the Forest Service publication, *Keeping It Wild: an interagency strategy to monitor trends in wilderness character across the National Wilderness Preservation System* (Landres et al. 2008). The framework provides a methodology for quantifying aspects of wilderness for long-term monitoring.

Unique measures of wilderness character, specifically relevant to the West Sister Island Wilderness, are described. However, every indicator within the framework must be represented by at least one measure, whether it is pertinent to the particular wilderness or not. This is done to ensure a comprehensive and consistent representation of Wilderness status throughout U.S. Fish and Wildlife Service NWR system lands.

The purpose of this report is multi-dimensional. It establishes a wilderness character monitoring program for the West Sister Island Wilderness and provides baseline data to assess how wilderness character is changing over time. Information gathered from this report may also aid resource specialists with making defensible management decisions within the West Sister Island Wilderness. Finally, this report is meant to accompany and explain the results of West Sister Island's wilderness character assessment that have been entered into a national wilderness character monitoring database.

SETTING OF WEST SISTER ISLAND WILDERNESS

West Sister Island Wilderness is within West Sister Island National Wildlife Refuge, a component of the Ottawa National Wildlife Refuge Complex. The Refuge Complex is a unique slice of marshland on the southwestern shore of Lake Erie stretching from just east of Toledo, Ohio, to 75 miles west of Cleveland, Ohio, in Lucas and Ottawa counties. Ottawa NWR Complex consists of three national wildlife refuges: Ottawa, Cedar Point and West Sister Island (Figure 1). This vast area is comprised of coastal wetlands, riverine marshes, wet prairies, and hardwood swamps, and this resource supports a tremendous diversity of wildlife, fish and plants.

As a major migration corridor, the area is vital to migratory birds including waterfowl, shorebirds, raptors and songbirds that need rest and food either after crossing Lake Erie on their way south or before they head back north to their breeding grounds. As much as 70 percent of the Mississippi flyway's population of black ducks uses Lake Erie marshes for migration. However, a small population of ducks (mainly mergansers, mallards, and black ducks) and a few thousand Canada geese remain

throughout the winter. Waterfowl numbers peak in the fall with large concentrations of dabblers, especially mallards and black ducks.

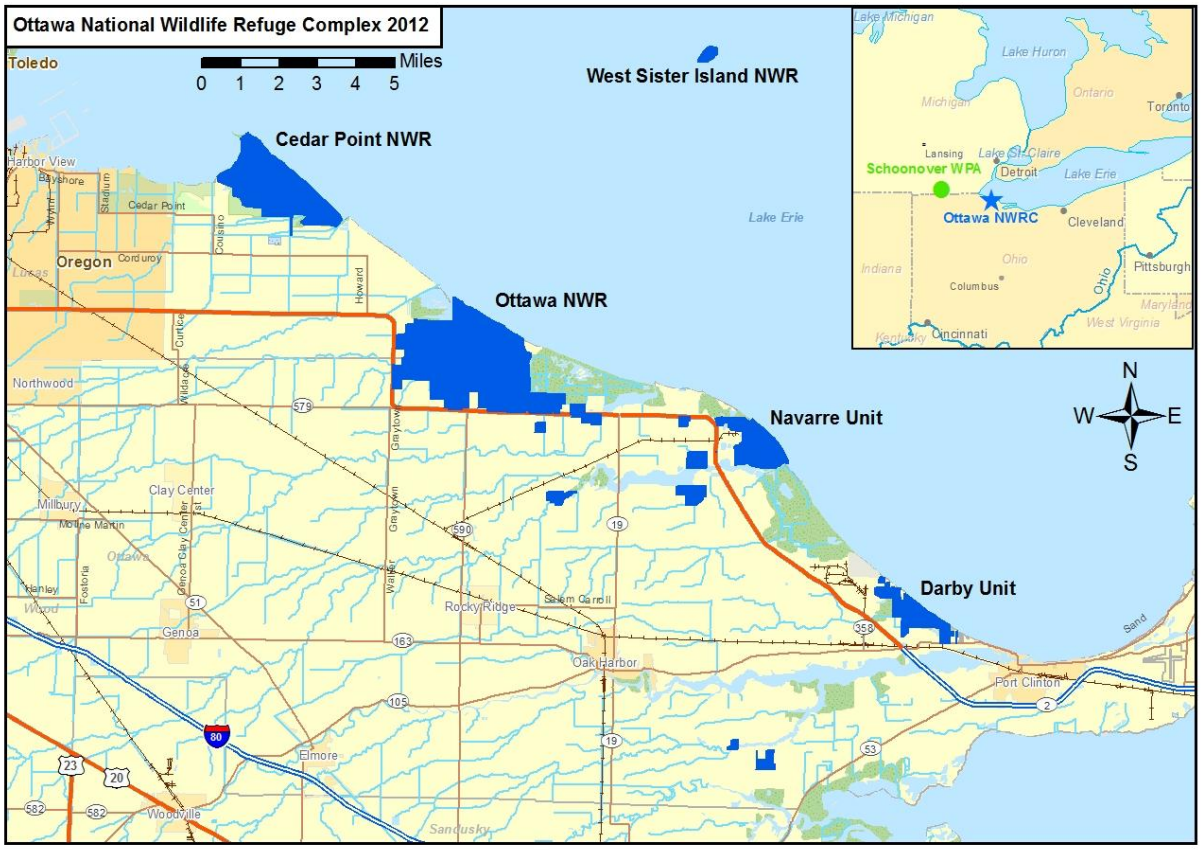


Figure 1. Location Map for Ottawa National Wildlife Refuge Complex, Ohio.

West Sister Island National Wildlife Refuge is the oldest member of the Ottawa Complex and the most isolated. It was established by Executive Order 7937 on August 2, 1938 "... as a refuge and breeding ground for migratory birds and other wildlife:.." and specifically to protect the largest wading bird nesting colony in the U.S. Great Lakes. A number of human activities that impacted the island before and after becoming a National Wildlife Refuge occurred. For instance, in the 1800's, the lighthouse and lighthouse keeper quarters were built on the south west third of the island. That area was cleared and grazed to support the various lighthouse keeper families. Lighthouse keepers and their families lived on the island until 1937. From April 1945 to 1951, the War Department used the island for target practice to test the stadiametric aircraft gunsights. Numerous shell casings, auxiliary fuel tanks, and other debris were left on the Island. Additionally, as of 2010, unexploded ordinance warning signs have been placed at island access points by the military. Although the island experienced a range of detrimental activities, it remains home to the largest great blue heron and great egret rookery in the U.S. Great Lakes. The

rookery also hosts snowy egrets, black-crowned night herons, double-crested cormorants, little blue herons, herring gulls and cattle egrets.

Southwest corner of West Sister Island, Ottawa NWR/USFWS

Geographic Setting

West Sister Island Wilderness is a 77-acre island located 9 miles offshore in the southwestern basin of Lake Erie. The Island is jointly owned by the U.S. Coast Guard (USCG) and the U.S. Fish and Wildlife Service (USFWS). Wildlife areas, monuments, memorials, a state park and a fish hatchery that provide complimentary services to the public are within a 25 mile radius of West Sister Island Wilderness.

Ecological Setting

West Sister Island appears to be flat topped, but actually rises gradually to the northeast to the height of 35 feet above the high water mark. Glacial grooves and igneous boulders left by the Pleistocene glaciers as they scoured the Lake Erie basin may be seen on the island. The island is composed of glacial till over a limestone shelf. The limestone shelf protrudes along the island showing where large coves have been eroding by hydrological forces. Most of the island is bordered by stony cliffs 15 to 20 feet high, but the side facing the mainland is a low, sloping gravelly beach which provides access to the island. The soil

contains a great amount of clay, loam and humus layers which annually receives a topically applied layer of nitrogen supplied by thousands of nesting colonial birds.

Cliff - West Sister Island Wilderness, Ottawa NWR/USFWS

Botanically, the Island is unique because of the nearly pure hackberry forest and its lack of mainland and other Lake Erie island plant species. Contributing to the island's dense vegetative cover are hackberry trees, as tall as 60-80 feet dominating the canopy, and 12 feet high poison ivy and 7-9 feet high Great Solomon's Seal, dominating the understory. Although successional progress has increased the height and density of the hackberry canopy, significant tree mortality and reduced available nesting habitat has been caused by the increased population and activity of double-crested cormorants. A few tiny wooded ponds in the interior of the island are surrounded by ground cover of jack-in-the-pulpit and trout lilies. The remaining few acres are open lands fringed with chokecherry and wild plum. A great variety of ferns, wildflowers, mushrooms, and other plant life are also found on the island.

West Sister Island is a very important nesting site for great blue herons and black-crowned night herons. Forty percent of herons/egrets in the Great Lakes nest on this island. Great blue herons and great egrets comprise 65 percent of nests. Other colonial waterbirds maintaining active nests are cattle egrets, herring gulls, and snowy egrets. Several other bird species and a few species of snakes comprise the remainder of the island's vertebrate fauna. Dense populations of woodland snails occur in the hackberry forest, along with a variety of other invertebrates.

The water around West Sister Island is too deep for the wading birds to feed in, so they must travel an 18-mile round-trip to the coastal wetland habitats on and around Ottawa NWR Complex to hunt for

food for themselves and their young. Studies have shown that these water birds will fly from West Sister Island Wilderness to the main refuge complex several times a day to feed their young. Very heavy feeding occurs in the marshes, drawdown areas, and mudflats created by Lake Erie wind tides.

History of establishing West Sister Island Wilderness

The passing of the Wilderness Act of 1964 (Act) allowed Federal land managers to propose unique and pristine ecosystems, and roadless islands within national wildlife refuges for preservation as *wilderness*. Wilderness areas are congressionally designated protected areas that remain in a natural condition and are free of significant anthropogenic manipulation. Wilderness is considered one of the most restrictive levels of protection an area can receive and wilderness areas remain a stronghold for many biotic communities.

To comply with the Act, the Secretary of the Department of the Interior (Secretary), directed the Bureau of Sport Fisheries and Wildlife (currently, U.S. Fish and Wildlife Service) to review all roadless areas of 5,000 acres or more and every roadless island within the National Wildlife Refuge System to determine their suitability or non-suitability as wilderness. Regulations of the Secretary published on February 22, 1966, required the Bureau of Sport Fisheries and Wildlife to review those areas qualified for study under the Wilderness Act that were (1) reasonably compact, (2) underdeveloped,(3) possessing general characteristics of wilderness, and (4) without improved roads suitable for public travel by conventional vehicles. The Secretary determined whether West Sister Island NWR or a portion of the NWR qualified for consideration as a wilderness through careful study and analysis of the public hearing record and other information pertaining to the ecological uniqueness and management objectives of the NWR. The public hearing record supported designation primarily based upon the large colonial waterbird colony on the island.

Upon recommendation from the Secretary to the President of the United States, Congress designated wilderness on all lands in West Sister Island NWR on January 3, 1975 (Public Law 93-632). It is the only wilderness area in the State of Ohio, and it is managed by Ottawa NWR, Oak Harbor, Ohio. The only means of reaching the island is by boat or seaplane. Public access to West Sister Island Wilderness is restricted to research and studies by authorized personnel, to provide protection to the colonial waterbirds and habitat, especially during breeding and nesting seasons.

Concerns regarding the status of the USFWS and USCG dual ownership of the island, the size of the NWR, and the boundary of the wilderness have surfaced since designation of the entire island as wilderness. The U.S. Coast Guard operates and maintains an automated beacon lighthouse located at the southwestern tip of the island. Prior to West Sister Island's designation as a wilderness area, the lighthouse and surrounding three acres was reserved for lighthouse purposes under the Executive Order of August 2, 1938.

A review of plat survey maps dating back as far as 1827, clarified that the island measured 77.13 acres, although several executive orders and federal register notices over the years have mistakenly indicated the island size of 85 acres. On April 1, 1975, the legal description and boundary of West Sister Island was re-affirmed and certified by the USFWS as containing the aggregate of 77.13 acres. The Wilderness boundary is described as comprising approximately 74 acres. The portion of the island that is owned by US CG is described as the remaining approximate 3-acre tract, which includes the automated beacon

lighthouse. To support the USFWS efforts on the island, USCG issues multi-year permits that allows the land outside of the wilderness boundary to be managed for refuge purposes.

Refuge Purposes

West Sister Island provides significant nesting and roosting habitat for colonial waterbirds. Although West Sister Island is jointly owned by USCG and USFWS, the National Wildlife Refuge provides protection for the largest wading bird colony within the Great Lakes region. Isolation and protection from disturbance during the nesting season is necessary for birds using the island.

The Refuge was established for the following:

"... a refuge and breeding ground for migratory birds and other wildlife." Executive Order 7937 dated August 2, 1938, President Franklin D. Roosevelt.

"…for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. 715d (Migratory Bird Conservation Act).

"…so as to provide protection of these areas…and to ensure…the preservation of their wilderness character…." (Wilderness Act of 1964, Public Law 88-577).

DOCUMENTS CONSULTED

The following documents assisted with identifying measures for wilderness character monitoring at West Sister Island Wilderness:

- Designation of the West Sister Island Wilderness Area Public Hearing Transcript [Bureau of Sport Fisheries and Wildlife] U.S. Fish and Wildlife Service (1969).
- Final Environmental Assessment Reducing Double-crested cormorant Damage in Ohio. USDA-Animal and Plant Health Inspection Service, USFWS- Migratory Bird Management/West Sister Island NWR, and Ohio Department of Natural Resources (2006).
- Ottawa National Wildlife Refuge Complex Annual Narrative Report. U.S. Fish and Wildlife Service (Years 1992 to 2004).
- Ottawa National Wildlife Refuge Complex Comprehensive Conservation Plan (CCP). U.S. Fish and Wildlife Service (2000).
- Status of Double-crested Cormorant in North America - Report. Linda Wires et al. 2001.

Additional Documents Consulted:

- Draft Report: The Fourth Decadal U.S. Great Lakes Colonial Waterbird Survey (2007-2010): Results and Recommendations to Improve the Scientific Basis for Conservation and Management. Francesca J. Cuthbert and Linda Wires (2011)
- Draft User Guide - Ch. 5, Monitoring Wilderness Character, National Park Service. (April 2012)
- Keeping it Wild: An Interagency Strategy to Monitor Trends in Wilderness Character Across the National Wilderness Preservation System. USDA, Forest Service. Peter Landres et al. (2008).

- Measuring Attributes of Wilderness Character – BLM Implementation Guide, Version 1.5. http://www.wilderness.net/toolboxes/
- USFWS, Ottawa NWR Files - West Sister Island Wilderness Area
- Status of Double-crested Cormorants in North America. Linda Wires et al. (2001)
- Technical Guide for Monitoring Selected Conditions Related to Wilderness Character. USDA, Forest Service. Peter Landres et al. (2009)
- USFWS, Division of Realty Files – West Sister Island Wilderness Area
- Various draft and final Wilderness Character Monitoring Reports (2011-2012)
- West Sister Island Wilderness Management Plan, DOI, U.S. Fish and Wildlife Service (1981)

STAFF CONSULTED

Jason Lewis, Wildlife Refuge Manager, Ottawa NWR
Ron Huffman, Wildlife Biologist, Ottawa NWR
Sadie O'Dell, Wildlife Biologist, Horicon NWR

PROCESS USED FOR IDENTIFYING MEASURES

Prior to visiting with the Ottawa NWR staff, I contacted staff in the Division of Realty, and the Division of Conservation Planning (USFWS, Midwest Regional Office) to gather notes from files, plans and reports related to West Sister Island Wilderness history, management, past and possible sources of degradation, and relevant ecological research. Keeping in mind the purpose for the wilderness designation, and referencing the *Keeping It Wild* document (Landres et al. 2008) and my notes, I prepared a draft list of measures. During my visit to the Refuge, I discussed with Jason Lewis and Ron Huffman the uniqueness of the wilderness, their concerns, and past, current, and future management activities. After reviewing the Refuge wilderness area files, I revised my draft list of potential measures based on the additional information gathered from the Refuge files and my previous meeting with staff. I highlighted those that I thought would be adequate to track the wilderness character of West Sister Island. Because I was working primarily with Ron Huffman, I provided the revised list to him for review. Later we met, went through the entire list of potential measures, and talked more about the wilderness management activities/issues and the relevance, purpose, and feasibility of collecting data for the potential measures. I then revised the list of potential measures based on our discussions.

Sadie O'Dell and I collaborated on revisions to the draft measures for each of the indicators, as she and I were preparing one WCM report for all of the Great Lakes Island Wilderness Areas (inclusive of West Sister Island Wilderness). Since most of the wilderness islands in the Great Lakes were similar, we felt it was important to maintain consistency among the measures that were being identified for most, if not all of the islands. A revised draft of the measures was sent to the Refuge for review and comment. Upon receipt of the Refuge's comments, Ron and I discussed each of the measures to clarify concerns, create a few new measures, make further revisions to several existing measures, and confirm which measures would be used for the WCM. I addressed concerns and created measures per suggestions from the Refuge. I then updated the measure prioritization and tracking WCM measures sheets, and forwarded these documents with the final revised draft measures to the Refuge for approval. Approved measures, related information and available data were entered into the database.

MEASURES USED

Twenty-one measures, identified below, are used to establish baselines to assess how wilderness character is changing over a period of time within the Wilderness.

UNTRAMMELED QUALITY

The document *Keeping It Wild* states the following regarding the untrammeled quality: The Wilderness Act states that wilderness is "an area where the earth and its community of life are untrammeled by man," and that "generally appears to have been affected primarily by the forces of nature." This quality is degraded by intentional modern human activities or actions that control or manipulate the components or processes of ecological systems inside the wilderness.

Monitoring Question	Indicator	Measure	Refuge Priority
What are the trends in actions that control or manipulate the "earth and its community of life" inside wilderness?	Authorized actions by the Federal land manager that manipulate the biophysical environment	[1.1] Index of double-crested cormorant management actions conducted by staff/authorized agents	H
		[1.2] Number of authorized research, survey, and monitoring projects that manipulate plants or wildlife habitat per year.	H
		[1.3] Number of permitted special uses that manipulate the biophysical environment	L
	Unauthorized actions that manipulate the biophysical environment	[1.4] Number of known incidents of unauthorized actions that influence the biotic and/or abiotic community inside wilderness	L

Measure 1.1: Index of double-crested cormorant management actions conducted by staff/authorized agents

Context and Relevance: West Sister Island NWR management focus is to provide habitat for the largest great blue heron, great egret, and black-crowned night heron rookery in the U.S. Great Lakes. Double-crested cormorants numbers began to increase steadily from 1992 to 1995, and in 1998, DCCOs estimates were at 1500 pairs (Wires et. al 2001). Double-crested cormorants are one of the wildlife species with resource needs and behaviors that conflict with human activities and resource uses. Conflicts include, but are not limited to cormorant foraging on populations of sport and commercial fish, and damage to vegetation and habitat used by other wildlife species. The increasing numbers of double-crested cormorants and the impacts of habitat loss and habitat degradation from DCCO fecal deposition to other colonial waterbirds in the wilderness resulted in the implementation of the damage

management program for West Sister Island. There are multiple factors to consider with regards to the implementation of cormorant management activities on a wilderness island. For example, the disturbance from cormorant control efforts on nearby islands, not under Refuge jurisdiction or without wilderness status, could potentially move birds to the wilderness island. The movement of birds and colonization of a wilderness island could be interpreted as a human induced changed rather than a force of natural selection and survival. The decision to implement control and the control methods used should be analyzed very carefully in a minimum requirement analysis. This measure is relevant to the indicator because it monitors significant actions that manipulate the biophysical environment. The biological control or manipulation of plants and animals by humans within wilderness disturbs the unadulterated state of the wilderness. However, refuge staff and partner agencies are unable to adequately assess the needs and health of various plant and animal populations within wilderness in the absence of such management actions and therefore, warrant a necessity to implement management actions within wilderness.

Description and Protocol: Monitored annually. This measure tracks the status and trend of authorized management actions conducted by staff and/or authorized agents that directly interfere with double-crested cormorant populations within wilderness. Management actions may include lethal and non-lethal take of birds under the Public Resource Depredation Order, including egg oiling, nest and/or egg destruction, and shooting of adult birds with suppressed rifles. In some cases, shooting activities may require additional time, the construction of a temporary blind, and spent ammunition (lead) on the island landscape. However, although the weighting assignment is generally consistent for all Great Lakes Islands Wilderness, the use of suppressed rifles from a distance on West Sister Island Wilderness is the least disturbing option of the three, as it requires relative little disturbance beyond 30-40 meters vs. physical visits to multiple nests for an extended period of time using either of the other two options. To account for these differences, an inherent weighting has been assigned to each management type based on its perceived level of impact to the biophysical resources, as described: Nest destruction - relatively low level of impact, assigned a value of 1; egg oiling - moderate level of impact, assigned a value of 2; and shooting birds - high level of impact, assigned a value of 3. A total management level value will be calculated for each management type by multiplying the inherent weight of each management type (i.e., nest destruction, egg oiling, adult birds shot) by the number of days the management type was implemented. The resulting products for each management type are summed to generate a total annual score for the entire wilderness. This sum is reported in the Wilderness Character Monitoring Database. This measure does not include actions conducted outside of wilderness. However, it should be noted that shooting offshore at the wilderness island does occur, and a couple of visits per year (vs. one visit per year) may be necessary in order to maintain DCCO numbers between 1500 to 2000 pair. Not all management methods have the same level of impact associated with them. Shooting adult birds and removing a member of the breeding population of a long-lived bird species has a greater impact on the population dynamics of this species than removing nests.

Table 1. Index of Double-crested Cormorant Management Actions Conducted by Staff/Authorized Agents

	Management Type (nest destruction, egg oiling, shooting)	Inherent Weight (nest destruction =1, egg oiling =2, shooting =3)	Number of Days Management Type Implemented	Score (inherent X units X days)	Comments
2012	Shooting	3	2	6	Visits dependent upon population levels. Goal to maintain 1,500 to 2,000 nesting pairs to minimize habitat damage.
TOTAL SCORE: 6					

Northwest corner of island in 2005 showing damage to habitat at peak of DCCO population, Ottawa NWR/USFWS

Northwest corner of island in 2009 showing habitat recovery following DCCO management, Ottawa NWR/USFWS

Source: Wildlife Biologist; Refuge Manager, Annual Narrative Reports, Final Environmental Assessment Reducing Double-crested cormorant Damage in Ohio –USDA/APHIS, Status of Double-crested Cormorants in North America-Wires et al. 2001, Fact sheet.

Data Adequacy: In 2012, one action (shooting adult birds) was conducted 2 days in the presence of, or authorized by the Refuge Manager or Wildlife Biologist. Scheduled visits of staff and/or authorized agent to West Sister Island to conduct these activities are known and reported to Ottawa NWRs Wildlife Biologist. The quality of this data was collected with a high degree of confidence and is representative of authorized actions within wilderness. Data entry sheets created and stored on the Refuge shared drive (S:\). The baseline value (6) is reported in the Wilderness Character Monitoring Database. Changes in this value must be interpreted very carefully, as described above.

Determining Significant Change: An increase in the number of authorized actions within wilderness results in a decrease in the trend for this measure and a decrease in Wilderness Character.

2012 Data value: 6

Measure 1.2: Number of authorized research, survey, and monitoring projects that manipulate plants or wildlife habitat per year

Context and Relevance: Hackberry forests and an abundant understory of poison ivy dominate most of West Sister Island NWR. While several colonial waterbird species utilize the trees for nesting, black-crowned night herons are tree nesters that prefer the shrub/understory layer. Successional progress over the years has increased the height and density of the canopy cover over the island, which has resulted in decreasing shrub/understory layer vegetation. Additionally, highly acidic guano from cormorants nesting and roosting in the same areas of nesting night-herons has raised concerns about impacts to the degrading habitat. Annual nest count surveys conveyed a decreasing trend in the number of nesting black-crowned night herons in the early 1990's. Consequently, black-crowned night herons have been pushed toward the western end of the island. Interest in removing vegetation to promote the shrub/understory layer for black-crowned night herons was acted upon in 1998. This measure is relevant to the indicator because it monitors significant actions that manipulate the biophysical environment. Wilderness, by definition, is land that has been unaltered and remains in a natural state. Although the biological control or manipulation of plants and animals by humans within wilderness disturbs the unadulterated state of the wilderness, Refuge staff and partner agencies are unable to adequately assess the needs and health of various plant and animal populations within wilderness without such management actions.

Description and Protocol: Monitored annually. This measure is a count of research, studies and monitoring projects that manipulate plant or wildlife habitat within wilderness. In 2012, no actions were conducted under this measure. However, from 1998 to 2004, a study involving cutting one-quarter to one-acre of hackberry trees was carried out on one-acre rotational plots adjacent to black-crowned night heron nesting habitat in the center of the wilderness island. Trees were cut to a height of 3-4 feet in hopes that stump sprouting would quickly provide additional nesting habitat for black-crowned night herons. The experimental plot was within the nest monitoring study area so that results of the cutting could be evaluated. To diminish trammeling, up to 12 personnel (Federal and State employees, and volunteers) used primitive methods, two-man crosscut saws, to cut the trees; this required an entire day to complete. This action has not been implemented since 2004. However, the Refuge intends to continue this management action in 2013. This measure does not include actions conducted outside of wilderness. The untrammeled quality is degraded when the number of authorized actions that manipulate the habitat within the wilderness increases. Although cutting hackberry forest is a purposeful decision to benefit a declining priority species, it is important to document this action because it trammel's the wilderness.

Nesting Black-Crowned Night Heron, Ottawa NWR/USFWS

Source: Wildlife Biologist; Refuge Manager, Annual Narrative Reports, CCP, Status of Double-crested Cormorants in North America -Linda Wires et al. 2001, Ottawa NWR Files - West Sister Island Wilderness Area, Website Fact sheet.

Data Adequacy: Scheduled visits of staff and authorized agents to West Sister Island to conduct these activities are known to Ottawa NWRs Wildlife Biologist. The quality of this data was collected with a high degree of confidence and represents the number of authorized actions within wilderness. Data entry sheets created and stored on the Refuge shared drive (S:\).

Determining Significant Change: Any increase in the number of actions within wilderness would be a significant enough impact to be interpreted as a change in the trend of wilderness character. Data will be reevaluated every year, but it is unlikely that data will ever change. Therefore this measure will likely always report a stable trend.

2012 Data value: The action (cutting hackberry trees in one-acre plots) was conducted under this measure between the years 1998 and 2004, but no records of number of acres cut per year during this time period were kept. The baseline value (1) has been entered into the database. The Refuge intends to continue this action in 2013.

Measure 1.3: Number of permitted special uses that manipulate the biophysical environment

Context and Relevance: Occasionally, capturing, banding/marking birds, and collecting specimens are essential for obtaining crucial scientific information. The concentrated and synchronous nesting typical of colonial waterbirds on the wilderness islands allows for banding on a scale not achievable for other groups of birds. Long life spans for some species and the fidelity of adults to breeding colonies allow for the accumulation of large, long-term sets of recapture and re-sighting data. Several research studies conducted at wilderness islands aim to address aspects of waterbird conservation across the Great Lakes region, such as species food habits, foraging behavior, energetics, movements, impacts on fish

populations, and biological impacts of contaminants on waterbird species. For example, the Herring gull continues to be recognized as a primary indicator species for environmental toxins in the Great Lakes. These studies often involve the removal of eggs for contaminant analysis. Additionally, some birds may be removed from islands for disease control to prevent an epidemic and protect the waterbird population at large when birds exhibit signs of botulism. This measure is relevant to the indicator because it monitors significant actions that manipulate the biophysical environment. Wilderness, by definition, is land that has been unaltered and remains in a natural state. Research and monitoring have many positive implications and often lead to improved management. However, some research projects often require capturing, banding and removing birds from the islands. This activity within wilderness disturbs the unaltered state of the wilderness and therefore mandates monitoring.

Description and Protocol: Monitored annually. This measure is a count of management actions (not the individual number of birds involved in the management action). Actions include opportunistic banding of colonial waterbird species, capturing, installing transmitters, collecting blood or performing tissue removal, or performing disease control actions. The refuge issues Special Use Permits to groups that wish to conduct research within the wilderness. The biological staff and refuge management follow-up with researchers and require activity reporting. Refuge staff keeps records of disease outbreaks and birds collected. Annually, the Ottawa NWR staff issues special use permits or visits West Sister Island Wilderness to band colonial waterbirds. This measure does not include actions conducted outside of wilderness. The untrammeled quality is degraded when there is an increase of actions requiring special use permits within the wilderness. This measure will show a degrading trend due to a purposeful decision to minimize the impacts of select species on the wilderness island and surrounding environment.

Source: Wildlife Biologist, Special Use Permits, Reports from researchers, Biological Staff, Annual Narrative Reports, Ottawa NWR Files - West Sister Island Wilderness Area, Refuge Management, Wilderness Management Plan.

Data Adequacy: Scheduled visits of staff and authorized agent occur once per year to West Sister Island to band birds. Ottawa NWRs Wildlife Biologist is aware of these annual visits. The quality of this data was collected with a high degree of confidence and represents the number of special use permits within wilderness. Data entry sheets created and stored on the Refuge shared drive (S:\).

Determining Significant Change: Banding is the only 2012 action within wilderness authorized by the U.S. Fish and Wildlife Service. This is the baseline recording for the wilderness character monitoring. Any increase or decrease in the number of actions would cause a significant enough impact to the wilderness to be interpreted as a degrading or improving trend. Data in this measure should be monitored and recorded in the Wilderness Character Monitoring Database annually.

2012 Data value: 1

Measure 1.4: Number of known incidents of unauthorized actions that influence the biotic and/or abiotic community inside wilderness

Context and Relevance: Refuge staff is unaware of any unauthorized actions taking place inside the West Sister Island Wilderness that could potentially influence the natural community of life. West Sister Island Wilderness is closed to the public. Visits to WSI by Refuge Staff are scheduled during

specific times of the year to minimize disturbance to breeding and nesting colonial waterbirds. Refuge staff would not be able to observe any unauthorized actions outside of scheduled site visits to the

Island. There are no instances of unauthorized actions previously recorded; little time is spent patrolling the Wilderness by law enforcement. This measure is relevant to the indicator because wilderness, by definition, is land where ecological functions have been allowed to operate without human manipulation. It is a place where natural conditions prevail and we, as humans, must accept the results with interest and humility. Unauthorized or illegal activities by outside parties can alter natural communities and trammel wilderness. These actions disturb the unadulterated state of wilderness and degrade wilderness character. While the federal land manager often has little control over such actions, the unauthorized manipulation of wilderness populations or communities must be taken very seriously and necessitates monitoring.

Description and Protocol: Monitored annually. This measure is a count of the number of unauthorized or illegal actions taken that manipulate plants, animals, water, soil, or fire inside wilderness. This measure includes all activities not authorized by the federal land manager that influence the natural environment of the wilderness. Examples of such actions are, but not limited to the introduction of mammalian predators, nest or egg destruction, shooting of colonial waterbirds, poaching, and seed, plant, or animal harvesting. In general, the untrammeled quality is degraded when there is an increase in the number of actions.

Source: Wildlife Biologist, Assistant Refuge Manager, Wilderness Management Plan.

Data Adequacy: Medium. The number of illegal and/or unauthorized activities occurring within wilderness is inherently difficult to keep track of with perfect accuracy. It is unrealistic to assume Refuge staff can be aware of any and all unauthorized actions taking place inside wilderness.

Determining Significant Change: Any increase in the number of actions within wilderness, results in a decrease in the trend for this measure and a decrease in Wilderness Character.

2012 Data value: 0

NATURAL QUALITY

The document *Keeping It Wild* states the following regarding the natural quality: The Wilderness Act states that wilderness is “protected and managed so as to preserve its natural conditions.” This quality is degraded by effects of modern people on the ecological systems inside the wilderness since the area was designated.

Monitoring Question	Indicator	Measure	Refuge Priority
What are the trends in terrestrial, aquatic, and atmospheric natural resources inside wilderness?	Plant and animal species and communities	[2.1] Presence of largest breeding colonial waterbird species on wilderness island	H
		[2.2] Index of status of select indigenous nesting waterbird species	H
		[2.3] Index of the status of select indigenous plant species	M
		[2.4] Index of status of species whose over-abundance threatens longevity of select indigenous nesting waterbird species on West Sister Island	H
	Physical resources	[2.5] Ozone air pollution	L
		[2.6] Total nitrogen wet deposition	L
		[2.7] Total sulfur wet deposition	L
		[2.8] Visibility	L
	Biophysical processes	[2.9] Change in mean annual temperature of wilderness	M
		[2.10] Change in annual amount of precipitation on wilderness island	M

Measure 2.1: Presence of largest breeding colonial waterbird species on Wilderness Island

Context and Relevance: The wilderness island provides significant nesting and roosting habitat for colonial waterbirds in the Great Lakes region. The intention of wilderness designation is to protect the natural and undisturbed quality of the island important for breeding and nesting habitat of native birds. The location of West Sister Island, near forage fish habitat, combined with its relatively undisturbed condition during spring and early summer, offer migratory bird species the necessary protected habitat. West Sister Island provides important habitat to several species of nesting colonial waterbirds including Double-crested Cormorant, Great Blue Heron, Great Egret, Black-crowned Night Heron, Herring Gull, Snowy Egret, Little Blue Heron, and Cattle Egret. The Upper Mississippi Valley/Great Lakes Regional Waterbird Conservation Plan includes West Sister Island on its list of the most important sites for breeding colonial waterbirds in the United States Great Lakes. The species chosen for monitoring is based on their high relevance to the natural character of West Sister Island Wilderness. Threats to these species and the island habitat, which include climate induced water level change, storm-driven waves, and invasion of exotic species (particularly invasive plants), have potential to change the character and composition of the island over a short period of time. Such threats could make some islands unavailable for nesting waterbirds.

Description and Protocol: This measure is a count of the largest breeding bird species within wilderness. The wilderness island provides important habitat to several species of nesting colonial waterbirds, particularly double-crested cormorant, great blue heron, great egret, and black-crowned night heron. The number of the most abundant colonial nesting waterbird species is summed and reported in the Wilderness Character Monitoring Database annually.

Great Egret Nest, Ottawa NWR/USFWS

Source: Wildlife Biologist, Annual Narrative Reports, Ottawa NWR Files - West Sister Island Wilderness Area, Wilderness Management Plan

Data Adequacy: All records of access to an island to survey, monitor, and/or inventory colonial nesting waterbirds are known and reported to the refuge. Visits are accurately recorded; therefore the quality of the data is high. Data entry sheets created and stored on the Refuge shared drive (S:\).

Determining Significant Change: Any change or absence of these nesting colonial waterbirds would be a significant impact to the wilderness and be interpreted as a degrading trend in wilderness character.

Table 1. Presence of Largest Breeding Colonial Waterbird Species on Wilderness Island

SPECIES	PRESENCE (X)
Great blue heron	X
Great egret	X
Black-crowned night heron	X
Double-crested cormorant	X

2012 Data Value: 4

Measure 2.2: Index of status of select indigenous nesting waterbird species

Context and Relevance: Species were chosen for inclusion in the wilderness character monitoring based on coordinated efforts to monitor waterbird species in the Great Lakes, species that historically and/or

currently nest on the wilderness islands, and those that have the potential to nest in the future without posing a threat to other nesting waterbird species. This measure assesses the impacts to waterbird populations based on the known history of the area to the present day and the role of West Sister Island Wilderness to protect and maintain waterbird populations.

Description and Protocol: This measure monitors the population size, trends and threats for each species. Threats refer to anthropocentric threats to the natural system and include high-use recreational boating, lighthouses, presence of invasive species, impacts from overabundance of native waterbird species, or impacts from contaminants and climate change. Each species nesting population is recorded, except for herring gull. The species is then classified by its population status and habitat threat with scores assigned by category. Scores are multiplied together for each species monitored under this measure, and the resulting products for each species are summed to generate a total score.

Species chosen for inclusion in the wilderness character monitoring are:

- Great Blue Heron (GTBH)
- Great Egret (GREG)
- Black-crowned Night Heron (BCNH)
- Herring Gull (HERG)

Species	Population Status	Score		Habitat Threat Level	Score		Total
	Increasing	1		Low/No Concern	1		
	Stable			Moderate Concern	2		
	Declining	2					
	Extirpated	3		High Concern	3		

Population Status Definitions:

- Indigenous: A species which historically inhabited the islands now designated as wilderness.
- *Threatened:* a species determined by the U.S. Fish and Wildlife Service to be likely to become endangered within the foreseeable future throughout all or a significant portion of its range.
- *Endangered:* A species determined by the U.S. Fish and Wildlife Service to be in danger of extinction throughout all or a significant portion of its range.
- *Increasing:* Species population is naturally increasing (i.e., increases are not due to a species crowding onto the wilderness because of human caused disturbance, as in the case of Double-crested cormorant control or habitat degradation elsewhere).
- *Stable:* Species population appears stable. If only presence or absence data is known, stable would indicate presence.
- *Declining:* Species population is decreasing.
- *Extirpated:* An indigenous species which no longer exists in this wilderness, but is believed to exist elsewhere.
- *State Endangered (SE):* A native species or subspecies threatened with extirpation from the state of Ohio.
- *State Threatened (ST):* A species or subspecies whose survival in Ohio is not in immediate jeopardy, but to which a threat exists.

- *Species of Concern (SC):* A species or subspecies which might become threatened in Ohio under continued or increased stress. Also, a species or subspecies for which there is some concern, but for which information is insufficient to permit an adequate status evaluation.

Threat Level Definitions:

- *Low/None:* Essential habitat of the species is not at risk either within the wilderness or outside the wilderness in the immediate area.
- *Moderate:* Essential habitat of the species is at moderate risk either within the wilderness or outside the wilderness in the immediate area.
- *High:* Essential habitat of the species is at high risk with improvement difficult or unlikely.

Source: Draft Report: The Fourth Decadal U.S. Great Lakes Colonial Waterbird Survey (2007-2010): Results and Recommendations to Improve the Scientific Basis for Conservation and Management (Cuthbert and Wires 2011), Wildlife Biologist, Ottawa NWR Files - West Sister Island Wilderness Area , Wilderness Management Plan

Data Adequacy: There is a high degree of confidence in the quality of this data; scores assigned are based on rigorous monitoring of the species. Data entry sheets created and stored on the Refuge shared drive (S:\).

Determining Significant Change: Any true change (increase or decrease) in the status and/or threats to the species chosen would be significant enough to indicate change in trend of wilderness character. Any numbers reported outside of this range would be an improvement or degradation of wilderness character. Overtime, an increase in the baseline value is a decrease in this indicator of the natural quality of wilderness character. Interpretation of changes in data as a shifting trend in wilderness character should be done on an individual basis.

Notes:

- Data for this report will be gathered every year to contribute to the Great Lakes Decadal Waterbird Census. The U.S. Fish and Wildlife Service have conducted three coordinated U.S. Great Lakes-wide surveys of breeding colonial waterbirds. Once per decade since the 1970s, a total count of all nests of each species present has been conducted. However, proper stewardship requires more frequent monitoring of the West Sister Island species
- Data should represent species status and threat level for populations in wilderness only.
- This measure monitors the current population trend and threats for each species. Trends for each species will be entered every year and will be compared to species trends from the baseline year.
- The use of broad categories is a crude measure however; it should be possible to use field experience and professional judgment to assign broad categories.
- A change in the baseline value over time could be caused by actions not under control of a wilderness manager, but still impact naturalness.
- The population status and habitat threat level of this measure may be subjective. Status classifications should be documented as completely as possible to assure adequate comparisons over time with changing staff. A reporting of the confidence level for the species status should be included.
- The professional review and advice of others knowledgeable about the species will be needed to determine the causes of changes to species and habitats. In some cases, a correlation between

a habitat threat and population decline may be as direct as a personal observation of physical change to habitat due to invasive species encroachment. In many cases, however it may be difficult to determine a cause of species or waterbird community decline.

- Changes in this reported value must be interpreted very carefully. Islands are extremely dynamic systems and are vulnerable and sensitive to change. Natural variability in species abundance and distribution at the population level must be taken into account. For example, changing water levels, inter-species competition, and species site fidelity should all be considered when assigning a population status and threat level score.
- If a species occurs in the wilderness, but data is not collected on the species, the status and habitat level should not be estimated. Identify the species in the table of listed species but do not include it in the monitoring.

Table 2. Index of Status of Select Indigenous Nesting Waterbird Species

Species	**Listing**	**Number of Nests** ±SE	**Population Status Score**	**Habitat Threat Level Score**	**Total (Status Score x Habitat Score)**	**Comments**
GTBH	None	927±160	1	1	1	Variability of nest counts using our subsampling methodology is high, no readily apparent population trends over the last 10 years for any species
GREG	SC	740±144	2	1	1	
BCNH	ST	480±194	1	3	3	Threat: succession of island, lack of preferred shrub nesting habitat
HERG	None	Unkn	1	2	2	Threat: predation by fox, climate change increasing storm intensity
Total Score: 8						

2012 Data Value: 8

Measure 2.3: Index of the status of select indigenous plant species

Context and Relevance: The presence and success of breeding and nesting colonial waterbirds rely heavily upon the health of the habitat on West Sister Island Wilderness. Several colonial waterbird species use hackberry trees for nesting; other waterbird species require the shrub/understory layer. Habitat loss and habitat degradation impact the longevity of the breeding and nesting waterbird communities in the wilderness. The primary management goal of the Refuge is to ensure sufficient nesting habitat for the largest heron/egret rookery in the U.S. Great Lakes persist. Therefore, it is important that the refuge monitor and conserve the species that depend on the wilderness.

Description and Protocol: Monitored annually. This measure is a rating of the population conditions of select plant species that the refuge has an invested interest in protecting and managing for the health of the ecosystem. The measure monitors the status, threat level, and trend for each plant species, currently, the hackberry tree. The rating is derived from an index value system, as follows: Each species is classified by its population status and habitat threat with scores assigned by category. Scores are multiplied together for each species monitored under this measure, and the resulting products for each species are summed to generate a total score and reported in the Wilderness Character Monitoring Database. Only species that utilize the wilderness area are included. Successional progress has increased the height and density of the hackberry canopy cover over the island, which has resulted in decreasing shrub/understory layer vegetation, preferred by black-crowned night herons for nesting. However, over the years, the highly acidic guano from double-crested cormorants has killed many hackberry trees, which has impacted nesting for indigenous herons and egrets. Threats also pertain to anthropocentric threats to the natural system and may include presence of invasive species, impacts from contaminants and climate change.

Species	Population Status	Score		Habitat Threat Level	Score		Total (Status Score x Habitat Score)
	Increasing	1		Low/No Concern	1		
	Stable			Moderate Concern	2		
	Declining	2					
	Extirpated	3		High Concern	3		

Population Status Definitions:

- *Indigenous:* A species which historically inhabited the islands now designated as wilderness.
- *Threatened:* A species determined by the U.S. Fish and Wildlife Service to be likely to become endangered within the foreseeable future throughout all or a significant portion of its range.
- *Endangered:* A species determined by the U.S. Fish and Wildlife Service to be in danger of extinction throughout all or a significant portion of its range.
- *Increasing:* Species population is naturally increasing.
- *Stable:* Species population appears stable. If only presence or absence data is known, stable would indicate presence.
- *Declining:* Species population is decreasing.
- *Extirpated:* An indigenous species which no longer exists in this wilderness, but is believed to exist elsewhere.

Threat Level Definitions:

- *Low/None:* Essential habitat of the species is not at risk either within the wilderness or outside the wilderness in the immediate area.

- *Moderate:* Essential habitat of the species is at moderate risk either within the wilderness or outside the wilderness in the immediate area.
- *High:* Essential habitat of the species is at high risk with improvement difficult or unlikely.

Source: Wildlife Biologist, Annual Narrative Reports, Ottawa NWR Files - West Sister Island Wilderness Area, Status of Double-crested Cormorants in North America-Wires et al. 2001, Fact sheet, Wilderness Management Plan.

Data Adequacy: There is a high degree of confidence in the quality of this data; score assigned is based on monitoring of the species. Data entry sheets created and stored on the Refuge shared drive (S:\).

Determining Significant Change: Any true change (increase or decrease) in the status and/or threats to the species chosen would be significant enough to indicate change in trend of wilderness character. Any numbers reported outside of this range would be an improvement or degradation of wilderness character. Overtime, an increase in the baseline value is a decrease in this indicator of the natural quality of wilderness character. Interpretation of changes in data as a shifting trend in wilderness character should be done on an individual basis.

Notes:

- Data should represent species status and threat level for populations in wilderness only.
- A change in the baseline value over time could be caused by actions not under control of a wilderness manager, but still impact naturalness.
- The population status and habitat threat level of this measure may be subjective. Status classifications should be documented as completely as possible to assure adequate comparisons over time with changing staff. A reporting of the confidence level for the species status should be included.
- The professional review and advice of others knowledgeable about the species will be needed to determine the causes of changes to species and habitats. In some cases, a correlation between a habitat threat and population decline may be as direct as a personal observation of physical change to habitat due to invasive species encroachment. In many cases, however it may be difficult to determine a cause of species community decline.
- Changes in this reported value must be interpreted very carefully. Islands are extremely dynamic systems and are vulnerable and sensitive to change. Natural variability in species abundance and distribution at the population level must be taken into account. For example, changing water levels, inter-species competition, and species site fidelity should all be considered when assigning a population status and threat level score.
- If a species occurs in the wilderness, but data is not collected on the species, the status and habitat threat level should not be estimated. Identify the species in the table of listed species but do not include it in the monitoring.

Table 3. Index of the Status of Select Indigenous Plant Species

Species	Listing	Population Status Score	Habitat Threat Level Score	Total (Status Score x Habitat Score)	Comments
Hackberry	Not listed	1	2	2	Stable population and low to moderate population threat as long as cormorant population control measures are maintained.
Total Score: 2					

2012 Data Value: 2

Measure 2.4: Index of status of select species whose over-abundance threatens longevity of the largest breeding colonial waterbird species on West Sister Island

Context and Relevance: The population size and status of plant and animal species whose over-abundance threatens the existence of indigenous nesting waterbird species and select indigenous plant species from year to year provides a glimpse into the stability and health of the ecosystem in the wilderness. These species may include native and non-native species. Currently, only one of these opportunistic species is highly prevalent in the Wilderness Area. This measure is relevant to the indicator because it monitors select species that impact the natural quality of wilderness.

Description and Protocol: This measure monitors the population size, trends and habitat threat level for each species. Threats considered include those posed to the essential habitat and/or food sources of select indigenous colonial nesting waterbirds and plant species, and atmospheric natural resources and processes. Maintaining double-crested cormorant to 1500 to 2000 nesting pairs is imperative to the sustainability of the nesting habitat for the indigenous colonial waterbirds of the wilderness. The species population is recorded. The species is then classified by its population status and threat to the islands habitat with scores assigned by category. Note that the habitat threat level used here is the opposite of the definition of the other measures in this document. It is intended to assess the threat of the species being monitored to the health of the habitat on the island—see population status and habitat threat level definitions. Currently only double-crested cormorant is considered in this measure. While other species may pose a threat, such as invasive plants to native ground vegetation, there are no current methods to address these issues without compromising the nesting colonial watebird populations on the island. Scores are multiplied together for each species monitored under this measure, and the resulting products for each species are summed to generate a total score for the entire wilderness. This sum is reported in the Wilderness Character Monitoring Database.

Species	Population Status	Score		Habitat Threat Level	Score		Total (Status Score x Habitat Score)
	Within	1		Low/No Concern	1		
	Below	2		Moderate Concern	2		
	Above	3		High Concern	3		

Population Status Definitions:

- *Within:* Species population is within established target levels that are believed to be sustainable without causing significant, wide-spread damage to native habitats.
- *Below:* Species population is below established target levels. For double-crested cormorants, this may trigger suspension of population control measures until the species recovers to target population levels.
- *Above:* Species population is above established target levels.

Threat Level Definitions:

- *Low/None:* Species poses little threat to overall habitat health on the island. Localized damage to native vegetation may still occur, but island habitats have the ability to recover from the damage.
- *Moderate:* Species is having adverse effects on island habitats, with localized and more widespread damage occurring. Tree health and vigor is decreased, with some mortality occurring. Habitat recovery may occur as higher density nesting areas shift around the island from year to year.
- *High:* Species is having significant adverse effects on the habitat of the island. Tree mortality is occurring, and habitat recovery is uncertain in the long term.

Table 4. Index of status of select species whose over-abundance threatens longevity of the largest breeding colonial waterbird species on West Sister Island

Species	Listing	Number of Nests ±SE	Population Status Score	Habitat Threat Level Score	Total (Status Score x Habitat Score)	Comments
Double-crested cormorant	Not listed	2407±300	3	3	9	Above target population, potential threat to island habitat is high
	Total Score: 9					

Source: Wildlife Biologist, Annual Narrative Reports, Ottawa NWR Files - West Sister Island Wilderness Area, Status of Double-crested Cormorants in North America-Wires et al. 2001

Data Adequacy: There is a high degree of confidence in the quality of this data; score assigned is based on rigorous monitoring of the species. Data entry sheets created and stored on the Refuge shared drive (S:\).

Determining Significant Change: Any. If there is an increase in the baseline value, it will reflect a degrading trend.

2012 Value: 9

Measure 2.5: Ozone air pollution

Context and Relevance: Ozone and its precursor emissions (nitrogen oxides and volatile organic compounds) can travel long distances, resulting in elevated ozone levels in wilderness. Air quality data is not monitored by the West Sister Island NWR staff; however, data is available from other agency monitoring programs. It is compiled and provided by the National Wildlife Refuge System's Center for Inventory and Monitoring (Center), in Fort Collins, CO. The natural quality is degraded when ozone levels increase.

Description and Protocol: Monitored annually. The measure assesses whether the numerical value calculated for ozone air pollution is increasing or decreasing over the averaging period. The 2012 value is presented as a 5-year average for years 2005-2009, which are the most recent years for which the Center has complete datasets for all values. Since monitors are not in close proximity to West Sister Island Wilderness, values have been interpolated between monitors. Therefore, a trend for the natural quality is not assessed.

Data Adequacy: All air quality data collected by the Center is used to determine the quality of air for the West Sister Island Wilderness Area. Monitoring stations are highly sophisticated and continually collect data. Data for this measure will be entered into the Wilderness Character Monitoring Database every five years.

Source: NWRS, Center for Inventory and Monitoring (Fort Collins, CO)

2012 Data Value: 75.5 ppb

Measure 2.6: Total nitrogen wet deposition

Context and Relevance: The concentration nitrogen in rain and snow is a major contributor to acid deposition, adversely affecting algae, aquatic invertebrates, amphibians, fish, soil microorganisms, plants, and trees. Air quality data is not monitored by the West Sister Island NWR staff; however, data is available from other agency monitoring programs. It is compiled and provided by the National Wildlife Refuge System's Center for Inventory and Monitoring (Center), in Fort Collins, CO. The natural quality is degraded when the level of nitrogen in acid deposition increases.

Description and Protocol: Monitored annually. The measure assesses whether the numerical value calculated for total nitrogen wet deposition is increasing or decreasing over the averaging period. The 2012 value is presented as a 5-year average for years 2005-2009, which are the most recent years for which the Center has complete datasets for all values. Since monitors are not in close proximity to West Sister Island Wilderness, values have been interpolated between monitors. Therefore, a trend for the natural quality is not assessed.

Data Adequacy: All air quality data collected by the Center is used to determine the quality of air for the West Sister Island Wilderness Area. Monitoring stations are highly sophisticated and continually collect data. Data for this measure will be entered into the Wilderness Character Monitoring Database every five years.

Source: NWRS, Center for Inventory and Monitoring (Fort Collins, CO)

2012 Data Value: 5.6 kg/ha

Measure 2.7: Total sulfur wet deposition

Context and Relevance: The concentration of sulfur in rain and snow is a major contributor to acid deposition, adversely affecting algae, aquatic invertebrates, amphibians, fish, soil microorganisms, plants, and trees. Air quality data is not monitored by the West Sister Island NWR staff; however, data is available from other agency monitoring programs. It is compiled and provided by the National Wildlife Refuge System's Center for Inventory and Monitoring (Center), in Fort Collins, CO. The natural quality is degraded when the level of sulfur in acid deposition increases.

Description and Protocol: Monitored annually. The measure assesses whether the numerical value calculated for total sulfur wet deposition is increasing or decreasing over the averaging period. The 2012 value is presented as a 5-year average for years 2005-2009, which are the most recent years for which the Center has complete datasets for all values. Since monitors are not in close proximity to West Sister Island Wilderness, values have been interpolated between monitors. Therefore, a trend for the natural quality is not assessed.

Data Adequacy: All air quality data collected by the Center is used to determine the quality of air for the West Sister Island Wilderness Area. Monitoring stations are highly sophisticated and continually collect data. Data for this measure will be entered into the Wilderness Character Monitoring Database every five years.

Source: NWRS, Center for Inventory and Monitoring (Fort Collins, CO)

2012 Data Value: 5.3 kg/ha

Measure 2.8: Visibility

Context and Relevance: Deciview is a visibility measurement that provides a cumulative haziness index used to express light extinction (i.e., the visibility a wilderness visitor would experience). Air quality data is not monitored by the West Sister Island NWR staff; however, data is available from other agency monitoring programs. It is compiled and provided by the National Wildlife Refuge System's Center for Inventory and Monitoring (Center), in Fort Collins, CO. The natural quality is degraded when deciview increases.

Description and Protocol: Monitored annually. The measure assesses whether the numerical value calculated for visibility is increasing or decreasing over the averaging period. The 2012 value is presented as a 5-year average for years 2005-2009, which are the most recent years for which the Center has complete datasets for all values. Since monitors are not in close proximity to West Sister Island Wilderness, values have been interpolated between monitors. Therefore, a trend for the natural quality is not assessed.

Data Adequacy: All air quality data collected by the Center is used to determine the quality of air for the West Sister Island Wilderness Area. Monitoring stations are highly sophisticated and continually

collect data. Data for this measure will be entered into the Wilderness Character Monitoring Database every five years.

Source: NWRS, Center for Inventory and Monitoring (Fort Collins, CO)

2012 Data Value: 12.1 Dv

Measure 2.9: Change in mean annual temperature (MAT) of wilderness

Context and Relevance: Wilderness managers need to be aware of the possible changes due to fluctuating temperatures and the mean annual temperature should be monitored given the readily available data. While changes in temperature may not be immediately apparent over the span of 20 years, it will be useful to have a record in the event the temperature does drastically change in future years. Over the 20th century, the northern portion of the Midwest, including the Upper Great Lakes, has warmed by almost 4 ºF (2 ºC), while the southern portion, along the Ohio River valley, has cooled by about 1 ºF (0.5 ºC). During the 21st century, models project that temperatures will increase throughout the Midwest and at a greater rate than has been observed in the 20th century. Even over the northern portion of the region, where warming has been the largest, an accelerated warming trend is projected for the 21st century, with temperatures increasing by 5 to 10 ºF (3 to 6 ºC). The average minimum temperature is likely to increase as much as 1 to 2 ºF (0.5 to 1 ºC) more than the maximum temperature. This measure is relevant because as water temperatures in lakes increase, major changes in Great Lakes ecosystems will very likely occur, such as a shift from cold-water fish species (e.g., trout) to warmer water species, (e.g., bass and catfish). Warmer water is also likely to create an environment more susceptible to invasions by non-native species. Changes in bird populations have already been linked to increasing temperatures and more changes are likely in the future.

Description and Protocol: West Sister Island Wilderness does not have a Remote Area Weather Station. The weather conditions for the wilderness island will have significant climatic differences, as compared to weather stations operated by the National Oceanic and Atmospheric Administration (N.O.A.A.) on the mainland. The weather data recorded at these weather monitoring stations tracks the temperature data pertinent for this measure. Data obtained for this measure will be gathered from the Toledo Express WSO AP NOAA weather station. It is the nearest weather station to West Sister Island, in which the data will provide Regional climate trends. The MAT is calculated by recording the mean annual temperature at 5-year intervals (the average temperature for every year in 5 year intervals). For example, mean annual temperature recorded for the 2012 measurement includes the average annual temperature of 2007-2011. The next date to be recorded would be 2017 and would include average temperatures for the years 2012-2016. The MAT is obtained by adding the Mean Daily Maximum for the month plus the Mean Daily Minimum for the month and then dividing that number by 2, (deriving the monthly average). These values are calculated for each annual report for the monitoring period (i.e., 2007-2011) and then the MAT is calculated for the recording period by dividing the sum of the monthly averages by 12 (deriving the annual average); the annual average is divided by number of years (i.e., 5). Temperature values can be found using the following url and locating the corresponding weather monitoring station (Toledo Express WSO AP) on the list: http://www.7.nchc.noaa.gov/IPS/cd/cd.html.

Source: NOAA/National Climatic Data Center- National Climatological Monthly Data Reports

Data Adequacy: Data are collected with a moderate degree of confidence from N.O.A.A. and does not accurately reflect exact conditions on the island due to the moderating influence of the lakes. The value

is calculated using annual temperature totals of the five years previous to the reporting year. Data will be measured every 5 years.

Determining Significant Change: The mean annual temperature is likely to fluctuate by several degrees every monitoring period. A significant change value is not as important as tracking temperature values to determine whether the overall mean annual temperature is increasing or decreasing in the region.

2012 Data Value: 50.3°F

Measure 2.10: Change in annual amount of precipitation on wilderness island

Context and Relevance: Wilderness managers need to be aware of possible changes on wilderness islands due to changes in precipitation patterns, and the annual amount of precipitation should be monitored given the data are readily available. Annual precipitation has increased, with many of the changes quite substantial, including as much as 10- to 20-percent increases during the 20th century. Much of the precipitation has resulted from an increased rise in the number of days with heavy to very heavy precipitation events. Precipitation is likely to continue its upward trend, at a slightly accelerated rate; 10- to 30-percent increases are projected across much of the region. Despite the increases in precipitation, increases in temperature and other meteorological factors are likely to lead to a substantial increase in evaporation, causing a soil moisture deficit, reduction in lake and river levels, and more drought-like conditions in much of the region. This measure is relevant because precipitation patterns are likely to have measureable impacts on Great Lakes Island ecosystems. Despite the projected increase in precipitation, increased evaporation due to higher summer air temperatures is likely to lead to reduced levels in the Great Lakes. In addition, the projected increase in very heavy precipitation events will likely lead to increased flash flooding and worsen agricultural and other non-point source pollution as more frequent heavy rains wash pollutants into rivers and the Great Lakes. This, coupled with warmer lake temperatures, is likely to stimulate the growth of algae, depleting the water of oxygen to the detriment of other dependent life forms in these ecosystems.

Description and Protocol: The weather conditions for the wilderness island will have significant climatic differences, as compared to weather stations operated by the National Oceanic and Atmospheric Administration (N.O.A.A.) on the mainland. The Toledo Express WSO AP NOAA weather station is the nearest weather station to West Sister Island, in which the data will provide Regional climate trends. The average precipitation within wilderness is calculated by recording the total inches of precipitation at 5-year intervals (the total precipitation [in inches] for every year in 5-year intervals) and then dividing the total number of inches by the sample period. For example, the average amount of precipitation recorded for 2012 baseline includes the precipitation measurements for 2007-2011. The subsequent baseline date recorded would be 2017 and would include precipitation measurements for the years 2012-2016. The average amount of precipitation is obtained by summing the annual monthly Total (in.) of Precipitation, divided by 12 to derive the average annual total; the average annual total is then divided by number of total years of the monitoring period (i.e., 5) for each annual report of the monitoring period (i.e., 2007-2011). Temperature values can be found using and locating the corresponding weather monitoring station (Toledo Express WSO AP) on the list: http://www.7.nchc.noaa.gov/IPS/cd/cd.html.

Source: NOAA/National Climatic Data Center- National Climatological Monthly Data Reports

Data Adequacy: Data are collected with a moderate degree of confidence from N.O.A.A. and does not accurately reflect exact conditions on the island due to the moderating influence of the lakes. The value is calculated using annual precipitation totals of the five years previous to the reporting year. Data will be measured every 5 years.

Determining Significant Change: The average amount of precipitation is likely to fluctuate by several degrees every monitoring period. A significant change value is not as important as tracking precipitation values to determine whether the overall amount of precipitation is increasing or decreasing in the region.

2012 Data Value: 40.04 inches

UNDEVELOPED QUALITY

The document *Keeping It Wild* states the following regarding the undeveloped quality: The Wilderness Act states that wilderness is "where man himself is a visitor who does not remain" and "with the imprint of man's work substantially unnoticeable." This quality is degraded by the presence of structures, installations, habitations, and by the use of motor vehicles, motorized equipment or mechanical transport that increases people's ability to occupy or modify the environment.

Monitoring Question	Indicator	Measure	Refuge Priority
What are the trends in non-recreational development inside wilderness?	Non-recreational structures, installations, and developments	[3.1] Number of signs within wilderness boundary	L
	Inholdings	[3.2] Number of inholdings within wilderness	L
What are the trends in mechanization inside wilderness?	Use of motor vehicles, motorized equipment, or mechanical transport	[3.3] Index of administrative mechanical transport and motorized equipment use in wilderness	L

Measure 3.1: Number of signs within wilderness boundary

Context and Relevance: Signs installed within West Sister Island Wilderness include refuge boundary markers, wilderness area, area closed, and unexploded ordinance signs. These signs are necessary to inform the public that the wilderness is closed to public access for the protection of the wilderness resources, and also for the public's safety of unexploded ammunition. This measure is relevant to the indicator because authorized units constructed within wilderness often require the need for equipment or machinery to install or build signs. The use of tools degrades the wilderness and the units installed decrease the need for self-reliance, although the wilderness is closed to public visitation.

Description and Protocol: An estimate of each sign type is provided. The sign type, location and number of each type are noted, but only an estimated count of the total number of signs is reported in the Wilderness Character Monitoring Database.

Table 5. Number of Signs Within Wilderness Boundary

SIGN TYPE OR NAME	LOCATION	NUMBER OF SIGNS
NWR boundary blue goose	Perimeter	4
Wilderness Area	Perimeter	4
Area Closed	Perimeter	4
Unexploded Ordinance	Perimeter	4
TOTAL ESTIMATE OF SIGNS 12		

Source: Wildlife Biologist, Assistant Refuge Manager, Wilderness Management Plan

Data Adequacy: Data adequacy is moderate since the location of the signs are generally known but have not been documented.

Determining Significant Change: An increase in the number of signs is considered significant change and would be in interpreted as degrading the undeveloped quality.

2012 Data Value: 12

Measure 3.2: Number of inholdings within wilderness

Context and Relevance: There are currently no inholdings within the wilderness but this measure is included due to the potential to have inholdings with future island acquisition, and inclusion also fulfills the national reporting guidelines. This measure is relevant to the indicator because it tracks the trends in potential inholdings of federal, state or private properties immediately within the wilderness.

Description and Protocol: This measure is a reporting of the number of inholdings found within the wilderness boundary. Inholdings are private, federal or state agency lands entirely within the wilderness boundary. Although there are no inholdings within the boundary of West Sister Island Wilderness, three acres adjacent to the wilderness contains a lighthouse which is under the jurisdiction of the U.S. Coast Guard. U.S. Coast Guard personnel periodically visit the refuge to ensure the automated light is operational.

Source: Refuge Manager, Wildlife Biologist, USFWS Realty Files-West Sister Island Wilderness, Wildlife Management Plan

Data Adequacy: Data adequacy is high since these properties are documented. All relevant refuge records were considered. Data will be reevaluated every five years.

Significant Change: An increase in the acreage of inholdings will be a significant impact and interpreted as degrading the undeveloped quality.

2012 Data Value: 0

Measure 3.3: Index of administrative mechanical transport, motorized equipment, and motor vehicle use in wilderness

Context and Relevance: The Wilderness Act discusses three forms of mechanization that degrades wilderness character: motor vehicles (aircraft and motorboats are included here), motorized equipment, and mechanical transport. Agency policies restrict the use of motorized equipment and mechanical transport, requiring authorization for such uses when deemed necessary. Motorized boats are used to access West Sister Island Wilderness, but they do not technically enter the wilderness which starts at the mean high water mark. Mechanical transport or motorized equipment have rarely been used in West Sister Island Wilderness except when such equipment was deemed the minimal tool necessary to accomplish refuge goals and to protect the wilderness resource. For example, using a battery powered drill to install refuge boundary signs in bedrock. This measure does not track the use of motorized equipment or mechanical transport by law enforcement. This measure is relevant because it tracks the actual use of motor vehicles, motorized equipment, or mechanical transport within wilderness.

Description and Protocol: Monitored annually. This single measure tracks the status and trends of all motorized and mechanized use authorized by the refuge staff in the wilderness. Not all equipment types have the same level of impact level associated with them. To account for these differences, an inherent weighting system has been assigned to each equipment type based on its perceived impact to social and biophysical resources, as shown in the table below. A "low" level of impact is a mechanical use that causes a small impact to the social environment and little or no impact to the biophysical environment (i.e., hand-held motorized equipment, battery power tool, or wheelbarrow). A "moderate" level of impact is a mechanized use that causes a large impact to the social environment (i.e., chainsaw, generator). A "high" level of impact is a mechanized use that causes a large impact to the social environment and biophysical environment (i.e., helicopter). A total use level value will be calculated for each motorized/mechanized use by multiplying the inherent weight of each type of equipment by the amount of actual use, as shown in the table below. The resulting products for each motorized/mechanized use are summed to generate a total score for the entire wilderness. This sum is reported to the Wilderness Character Monitoring Database.

Equipment Type	Inherent Weight		Amount of Use	Use Weight	Total
Battery-powered tool	1		One piece, one day	1	
Wheelbarrow	1				
Chain saw	2		Multiple pieces, one day	2	
Generator	2		One piece, multiple days	2	
Helicopter	3		Multiple pieces, multiple days	3	

Definitions

Mechanical Transport: Any contrivance for moving people or material in or over land, water, or air, having moving parts that provides a mechanical advantage to the user, and that is powered by a living or non-motorized power source. This includes, but is not limited to, hang gliders, parachutes, bicycles, game carriers, carts, and wagons. It does not include wheelchairs when used as a necessary medical

appliance. It also does not include rafts, kayaks, canoes, or similar primitive devices without moving parts.

Motorized Equipment: Machines that are not used for transportation, but powered by a motor, engine, or other nonliving power source. This includes, but is not limited to, such machines as chain saws and generators. It does not include small battery or gas powered hand-carried devices such as shavers, wristwatches, flashlights, cameras, stoves, or other similar small equipment.

Motor vehicles: Machines used to transport people or material across or over land, water, or air, and which are powered by the use of a motor, engine, or other nonliving power source. This includes, but is not limited to ATVs, motor boats, and aircraft that either land or drop-off or pick-up people or material (i.e., not aircraft that merely fly over the wilderness).

Source: Refuge Biologist, Refuge Manager.

Data Adequacy: The quality of the data was collected with a moderate to high degree of confidence. For 2012, data came from interviews with refuge staff. Data sheets for accurate recording of administrative mechanical and motorized uses have been developed and will be utilized for future record keeping; stored in the Wilderness folder on the shared drive (S:\). This data will be reported in the Wilderness Monitoring Database annually.

Determining Significant Change: It should be noted that the specific weights are subjectively determined. Best professional judgment was used when assigning weights. An increase in the baseline value degrades the undeveloped quality -- any change is a significant change since the Wilderness Act prohibits the use of motorized equipment, and mechanical transport.

Table 6. Index of Administrative Mechanical Transport, Motorized Equipment, and Motor Vehicle Use in Wilderness

Equipment Type	Inherent Weight	Amount of Use	Use Weight	Total Weight (inherent x use)	Comments
Wheelbarrow	1	Multiple pieces, multiple days	3	3	Used to gather cormorants for composting
TOTAL: 3					

2012 Data Value: 3

SOLITUDE OR PRIMITIVE AND UNCONFINED RECREATION QUALITY

The document *Keeping It Wild* states the following regarding the solitude or primitive/unconfined recreation quality: The Wilderness Act states that wilderness has "outstanding opportunities for solitude or a primitive and unconfined type of recreation." This quality focuses on how the *opportunity* for people to experience wilderness is changing; it is not directly about visitor experiences per se. This quality is degraded by settings that reduce these opportunities, such as visitor encounters of modern civilization, recreation facilities, and management restrictions on visitor behavior.

Monitoring Question	Indicator	Measure	Refuge Priority
What are the trends in outstanding opportunities for solitude inside wilderness?	Remoteness from sights and sounds of people inside the wilderness	[4.1] Index of number of groups (Researchers and Refuge Staff) visiting wilderness	M
	Remoteness from occupied and modified areas outside the wilderness	[4.2] Index of the degree of accumulated trash and debris on the wilderness island	M
What are the trends in outstanding opportunities for primitive and unconfined recreation inside wilderness?	Facilities that decrease self-reliant recreation	[4.3] Number of agency provided recreation facilities	L
	Management restrictions on visitor behavior	[4.4] Number of restrictions on visitor behavior	L

Measure 4.1: Index of number of groups (Researchers and Refuge Staff) visiting wilderness

Context and Relevance: West Sister Island Wilderness is closed to public use. Consequentially, the wilderness itself does not receive casual/unauthorized visitors. Visitors to the island consist of authorized researchers and refuge staff involved with monitoring and/or research activities. This measure is relevant because part of Wilderness Character is having the opportunity to experience the "remoteness" one feels when they are alone and removed from all the noise of urbanization, vehicles, crowds as well as the sights of urbanization. Tracking access to island by staff and researchers within wilderness is important to monitor because as the number of groups visiting increases, the opportunity for solitude declines.

Description and Protocol: This measure is a reporting of the number of groups visiting the wilderness island. Although researchers and refuge staff visit the wilderness annually to conduct necessary management activities, opportunities to experience solitude may occasionally occur. The management activity is recorded. The number of boats to transport each management type group and the number of visits are recorded. Scores are multiplied for each management type group under this measure, and the resulting products for each group are summed to generate a total score for the entire wilderness. The total number of groups visiting the wilderness annually is reported in the Wilderness Character Monitoring Database.

Table 7. Index of Number of Groups (Researchers and Refuge Staff) Visiting Wilderness

Management Activity	Number of Boats Used	Number of Visits	Total (Boat score x Visit score)
Double-crested Cormorant Management	1	2	2
Nest Counts & Banding	2	1	2
Vegetative Monitoring	1	1	1
Beach Clean-up	1	1	1
Lighthouse Management	1	2	2
GRAND TOTAL			
8			

Source: Wildlife Biologist, Special Use Permits, Biological Staff, Refuge Manager, Wilderness Management Plan

Data Adequacy: The quality of the data was collected with a high degree of confidence. The data was derived from interviews with refuge staff, staff records and special use permits. Data sheets created and stored on Refuge shared drive (S:\).

Determining Significant Change: Any increase in the number of groups above the baseline value results in a decrease in the trend for this measure which degrades the solitude or primitive and unconfined recreation quality.

2012 Data Value: 8

Measure 4.2: Index of the degree of accumulated trash and debris on the wilderness island

Context and Relevance: Islands in large water bodies are the recipients and often the terminus for debris and litter. The wilderness islands are no exception. Waves wash in all sorts of trash and debris that litter the islands. Plants and animals that inhabit the wilderness can also be impacted by the debris which can bring chemicals or foreign elements into the environment, and degrade the habitat, or be consumed by wildlife. This measure is relevant because, although the wilderness is closed to the public, trash, litter, and debris along a shoreline or within wilderness can have major effects on one's wilderness experience of solitude.

Description and Protocol: West Sister Island Wilderness is scored by the degree debris and litter present. Degree of litter indexed value scores are recorded as : 1 = Very Low (only small pieces of litter in very few locations); 2 = Low (some evidence of small debris at several locations); 3 = Moderate (some larger pieces of debris are accumulating along with several to many small pieces of litter); 4 = High (many pieces of larger debris and many pieces of small litter have accumulated); 5 = Very High (the debris and litter has accumulated to a much higher level than previously stated). Scores throughout the year are summed to generate a total score for the entire wilderness. The sum is reported in the Wilderness Character Monitoring Database.

Source: Assistant Refuge Manager, Biological Staff, Wilderness Management Plan

Data Adequacy: Since the degree of litter and debris is estimated and based on best professional judgment, confidence in the quality of data is moderate within the degree categories assigned for this measure. Data will be reported in the Wilderness Character Monitoring Database annually.

Determining Significant Change: Any increase in the total score of debris and litter recorded after the initial survey, results in a decrease in the trend for this measure and a degradation of wilderness character. If there is effort to remove debris and litter, this would likely cause a shift in the degree of litter present and be an improvement to wilderness character. Interpreting changes in data as a shifting trend of wilderness character should be done on an individual basis.

2012 Data Value: 2

Measure 4.3: Number of Agency provided recreation facilities

Context and Relevance: The entire West Sister Island Wilderness is closed to public use. Consequentially, there are no opportunities for primitive and unconfined recreation within the wilderness but this measure is included as it fulfills the national reporting guidelines. At present, West Sister Island Wilderness has no such facilities and it is highly unlikely that such facilities will be installed in the future because the island will remain closed to casual visitors.

Description and Protocol: This measure tracks the trends in permanent facilities that are used primarily for recreational purposes, regardless of whether they are for resource protection or visitor convenience. Data collected for this measure are from simple numerical counts of the number of physical installations including any unit or object created, set in place, erected, built, or positioned by U.S. Fish and Wildlife within wilderness.

Source: Wildlife Biologist, CCP

Data Adequacy: The quality of the data was collected with a high degree of confidence and is representative of the number of administrative installations and structures within the wilderness area. Data will be reevaluated every five years, but it is unlikely that the data will ever change. Therefore, this measure will likely always report a stable trend.

Determining Significant Change: Any change in this data would be a significant enough impact to be interpreted as degrading the trend of wilderness character.

2012 Data Value: 0

Measure 4.4: Number of restrictions on visitor behavior

Context: West Sister Island Wilderness is closed entirely to the public use. This restriction is in place to protect the sensitive habitat and nesting waterbird populations.

Description and Protocol: Monitored annually. This measure is a simple count of the number of restrictions that the agency places on visitor behavior inside the wilderness. Since the entire island is closed to the public, the sole restriction is counted and reported.

Source: CCP, Ottawa NWR Files - West Sister Island Wilderness Area, Refuge Manager, Wildlife Biologist, Fact Sheet, Wilderness Management Plan

Data Adequacy: The quality of the data was collected with a high degree of confidence and is representative of the number of the restrictions on visitor behavior. Data will be reevaluated every five years, but it is unlikely that the data will ever change. Therefore, this measure will likely always report a stable trend.

Significant Change: An increase in the number of restrictions within wilderness, results in a decrease in the trend for this measure and a decrease in Wilderness Character.

2012 Data Value: 1

DROPPED MEASURES

The following are measures that were considered, but ultimately dropped before priorities were assigned.

UNTRAMMELED QUALITY		
INDICATOR	**MEASURE**	**REASON NOT USED**
Authorized actions that manipulate biophysical environment	Number of actions to manage fire	This measure was not included in monitoring because no prescribed burns are currently conducted on West Sister Island Wilderness and prescribed burns are not feasible for Refuge to monitor.
NATURAL QUALITY		
Physical Processes	Presence and amount of contaminants	Data on measuring mercury had been collected a couple of times in the past, in part as required by Ohio's composting laws. It's unlikely that this will continue to be required in the future; therefore, it is not feasible for the Refuge to monitor.
UNDEVELOPED QUALITY		
Non-recreational structures, installations, or developments	Index of abandoned structures	This measure was not included because of the low relevance to wilderness. Three acres of West Sister Island, which is under the jurisdiction of the U.S. Coast Guard and not within the wilderness boundary, contains fuel tanks, shell casings, and the foundation of the light keeper's house.

SOLITUDE or PRIMITIVE and UNCONFINED RECREATION QUALITY		
INDICATOR	**MEASURE**	**REASON NOT USED**
Remoteness from sights and sounds of people inside the wilderness	Number of wilderness acres where man-made structures are visible	This measure was not included in the monitoring because of low relevance to assessing wilderness character. The island is remote and closed to the public; therefore it is not feasible for the Refuge to monitor.
	Night sky light pollution	This measure was not included in the monitoring because of low relevance to assessing wilderness character. The island is remote and closed to the public; therefore it is not feasible for the Refuge to monitor.
OTHER FEATURES		
Loss of statutorily protected cultural resources	Number of unauthorized removals of cultural resources	This measure was not used because there are no protected cultural resources within the wilderness boundary.

CONCLUSIONS

This WCM report incorporates issues unique to West Sister Island Wilderness, and pertinent to all of the Great Lakes Island Wilderness Areas. Management actions for several of the measures are already being implemented; therefore collection of some of the data will not create an additional burden on the Refuge staff. This report uses only data that is already routinely collected or is relatively simple to obtain from a national source. However, Refuge staff feel that even the seemingly minor increase in workload WCM requires is detrimental in the long term, within the context of an era of permanent loss of positions and decreased budgets. Additional incremental burdens of data calls, reporting requirements, etc., are added annually to field stations workloads, which cumulatively over time negatively affect the ability to accomplish on the ground conservation delivery.

Although there are few management activities that occur on West Sister Island, they are routinely conducted to ensure the Island provides significant nesting and roosting habitat for colonial waterbirds. A major concern of the Refuge staff is the degradation and loss of habitat for these species, caused by double-crested cormorants. Consistent management and monitoring of DCCOs activities must continue to be undertaken in order to prevent significant impacts to the select indigenous waterbirds, as supported by data and photos. Several years of data and photos document the increasing demise of hackberry forests by DCCO behavior. The recommendation to consider using "Guidelines for Long-term Monitoring Protocols" (Oakley et al. 2003) which is accessible on the National Park Service's, Inventory and Monitoring website, is offered to create formal standardized photography protocol.

This report and the measures contained capture the character of West Sister Island Wilderness. The Ottawa NWR staff are very attentive and abreast of the issues of the wilderness. They have been very supportive in providing assistance to prepare this report. I believe the measures in place will provide stable and/or increasing future trends in the wilderness character.

APPENDIX A - Priority Ranking of All Measures

PRIORITIZING POTENTIAL MEASURES OF WILDERNESS CHARACTER FOR WEST SISTER ISLAND

The potential measures are described under the appropriate indicators. Four criteria (significance, vulnerability, reliability, and feasibility) are used to rank each potential measure in the worksheet. These criteria have proven to be readily understood and useful. These criteria are defined as:

Significance—The degree to which the measure is directly related to the quality of wilderness character and is relevant and useful to Refuge staff in the management of that quality.

Vulnerability—Both the current and near-term (within 10-15 years) level of risk or threat to a quality of wilderness character.

Reliability—Whether the measure can be monitored accurately with a high degree of confidence and would yield the same result if measured by different people at different times.

Feasibility—How practical it would be to monitor the measure.

For those measures that do not have existing data sets, assign numerical scores based on how much additional effort they will require to monitor. Factors such as cost, time, and staffing will come into play. This category uses a slightly different point system which forces a decision which provides another point in the ranking process where some measures can be readily dismissed. If a measure can be reasonably monitored considering the limitations imposed by cost or availability of staff time, it is assigned 1 point; if not, it is assigned 0 points and dismissed.

Use the criteria and ranking guide below to create an overall score for each measure. If the combined score for criteria A and B is ≤ 2, STOP and do not score criteria C and D. Those measures with the highest overall scores should be the highest priority for assessing trends in wilderness character.

A. Level of significance (the measure is highly relevant to the quality and indicator of wilderness character, and is highly useful for managing the wilderness): High = 3 points, Medium = 2 points, Low = 1 point

B. Level of vulnerability (measures an attribute of wilderness character that currently is at risk, or might likely be at risk over 10-15 years): High = 3 points, Medium = 2 points, Low = 1 point

C. Degree of reliability (the measure can be monitored accurately with a high degree of confidence, and would yield the same result if measured by different people at different times): High = 3 points, Medium = 2 points, Low = 1 point

D. Degree of feasibility (the measure is related to an existing effort or could be monitored without significant additional effort): High = 1 point, Low = 0 point (if 0 is given, do not use)

POTENTIAL MEASURE	Criteria for Prioritizing Potential Measures				OVERALL SCORE
	A. Significance	B. Vulnerability	C. Reliability	D. Feasibility	
UNTRAMMELED QUALITY					
Indicator: Authorized actions that manipulate the biophysical environment **Measure:** Index of double-crested cormorant management actions conducted by staff/authorized agents	3	3	3	1	7
Indicator: Authorized actions that manipulate the biophysical environment **Measure**: Number of authorized research, survey, and monitoring projects that manipulate plants or wildlife habitat per year.	3	3	3	1	7
Indicator: Authorized actions that manipulate the biophysical environment **Measure**: Number of permitted special uses that manipulate the biophysical environment	1	1			
Indicator: Unauthorized actions that manipulate the biophysical environment **Measure:** Number of known incidents of unauthorized actions that influence the biotic and/or abiotic community inside wilderness	1	1			
NATURAL QUALITY					
Indicator: Plant and animal species and communities **Measure:** Presence of largest breeding colonial waterbird species on wilderness island	3	3	3	1	7
Indicator: Plant and animal species and communities **Measure:** Index of status of select indigenous nesting waterbird species.	3	3	3	1	7
Indicator: Plant and animal species and communities **Measure:** Index of status of select indigenous plant species	3	3	3	1	7

POTENTIAL MEASURE	Criteria for Prioritizing Potential Measures				OVERALL SCORE
	A. Significance	B. Vulnerability	C. Reliability	D. Feasibility	
NATURAL QUALITY (CONTD)					
Indicator: Plant and animal species and communities **Measure:** Index of status of species whose over-abundance threatens longevity of select indigenous nesting waterbird species on West Sister Island	3	3	3	1	7
Indicator: Physical resources **Measure:** Ozone air pollution	3	1	1	1	6
Indicator: Physical resources **Measure:** Total nitrogen wet deposition	3	1	1	1	6
Indicator: Physical resources **Measure:** Total sulfur wet deposition	3	1	1	1	6
Indicator: Physical resources **Measure:** Visibility	3	1	1	1	6
Indicator: Biophysical processes **Measure:** Change in mean annual temperature of wilderness	2	2	1	1	6
Indicator: Biophysical processes **Measure:** Change in annual average amount of precipitation on wilderness island	2	2	1	1	6
UNDEVELOPED QUALITY					
Indicator: Non-recreational structures, installations, and developments **Measure:** Number of signs within wilderness boundary	1	1			
Indicator: Inholdings **Measure:** Number of inholdings within wilderness	1	1			
Indicator: Use of motor vehicles, motorized equipment, or mechanical transport **Measure:** Index of administrative mechanical transport and motorized equipment use in wilderness	1	1			

POTENTIAL MEASURE	Criteria for Prioritizing Potential Measures				OVERALL SCORE
	A. Significance	B. Vulnerability	C. Reliability	D. Feasibility	
SOLITUDE OR PRIMITIVE AND UNCONFINED RECREATION QUALITY					
Indicator: Remoteness from sights and sounds of people inside the wilderness **Measure:** Index of number of groups (Researchers and Refuge Staff) visiting wilderness	1	1			
Indicator: Remoteness from occupied and modified areas outside the wilderness **Measure:** Index of the degree of accumulated trash and debris on the wilderness island	1	1			
Indicator: Facilities that decrease self-reliant recreation **Measure:** Number of agency provided recreation facilities	1	1			
Indicator: Management restrictions on visitor behavior **Measure:** Number of restrictions on visitor behavior	1	1			
Other Features Quality					
Indicator: Loss of cultural resources **Measure:** Number of unauthorized removals of cultural resources	Quality is Not Applicable				
Indicator: Loss of paleontological resources **Measure:** Number of unauthorized removals of paleontological or geological resources	Quality is Not Applicable				

APPENDIX B - Data Sources and Protocols for All Measured Used

USFWS National Wildlife Refuge System Wilderness
Keeping Track of Wilderness Character Monitoring Measures (West Sister Island)

Measure	Priority (H, M, L)	Detailed Description of the Data Source(s) and Protocols for How the Data Were Gathered
Untrammeled Quality		
[1.1] Index of double-crested cormorant management actions conducted by staff/authorized agents	H	Wildlife Biologist, Refuge Manager, Annual Narrative Reports, Final Environmental Assessment Reducing Double-crested cormorant Damage in Ohio –USDA/APHIS, Status of Double-crested Cormorants in North America-Wires et al. 2001, Fact sheet: Monitored annually. An inherent weighting has been assigned to each management type based on its perceived level of impact to the biophysical resources, as described: Nest destruction - relatively low level of impact, assigned a value of 1; egg oiling - moderate level of impact, assigned a value of 2; and shooting birds - high level of impact, assigned a value of 3. A total management level value will be calculated for each management type by multiplying the inherent weight of each management type (i.e., nest destruction, egg oiling, adult birds shot) by the number of days the management type was implemented. The resulting products for each management type are summed to generate a total annual score for the entire wilderness. This sum is reported in the Wilderness Character Monitoring Database.
[1.2] Number of authorized research, survey, and monitoring projects that manipulate plants or wildlife habitat per year.	H	Wildlife Biologist, Refuge Manager, Annual Narrative Reports, CCP, Status of Double-crested Cormorants in North America - Linda Wires et al. 2001, Ottawa NWR Files - West Sister Island Wilderness Area, Website Fact sheet: Monitored annually. This measure is a count of research, studies and monitoring projects that manipulate plants or wildlife habitat within wilderness.
[1.3] Number of permitted special uses that manipulate the biophysical environment	L	Wildlife Biologist, Special Use Permits, Reports from researchers, Biological Staff, Annual Narrative Reports, Ottawa NWR Files - West Sister Island Wilderness Area, Refuge Management: Monitored annually. This measure is a count of management actions (not the individual number of birds involved in the management action). Actions include banding, capturing, installing transmitters, collecting blood or performing tissue removal or performing disease control actions. The refuge issues Special Use Permits to groups that wish to conduct research within the wilderness. The biological staff and refuge management follow-up with researchers and require activity reporting. Refuge staff keeps records of disease outbreaks and birds collected.

Measure	Priority (H, M, L)	Detailed Description of the Data Source(s) and Protocols for How the Data Were Gathered
Untrammeled Quality (contd)		
[1.4] Number of known incidents of unauthorized actions that influence the biotic and/or abiotic community inside wilderness	L	Wildlife Biologist, Assistant Refuge Manager, Wilderness Management Plan: Monitored annually. This measure is a count of the number of unauthorized or illegal actions taken that manipulate plants, animals, water, soil, or fire inside wilderness. This measure includes all activities not authorized by the federal land manager that influence the natural environment of the wilderness. Examples of such actions are, but not limited to the introduction of mammalian predators, nest or egg destruction, shooting of colonial waterbirds, poaching, seed, plant, or animal harvesting.
Natural Quality		
[2.1] Presence of largest breeding colonial waterbird species on wilderness island	H	Wildlife Biologist, Annual Narrative Reports, Ottawa NWR Files - West Sister Island Wilderness Area: This measure is a count of the largest breeding bird species within wilderness. The wilderness island provides important habitat to several species of nesting colonial waterbirds, particularly double-crested cormorant, great blue heron, great egret, and black-crowned night heron. The number of the most abundant colonial nesting waterbird species is summed and reported in the Wilderness Character Monitoring Database annually.
[2.2] Index of status of select indigenous nesting waterbird species	H	Draft Report *The Fourth Decadal U.S. Great Lakes Colonial Waterbird Survey (2007-2010): Results and Recommendations to Improve the Scientific Basis for Conservation and Management* (Cuthbert and Wires 2011), Wildlife Biologist, Ottawa NWR Files - West Sister Island Wilderness Area , Wilderness Management Plan: This measure monitors the population size, trends and threats for each species. Each species nesting population is recorded. The species is then classified by its population status and habitat threat with scores assigned by category. Scores are multiplied together for each species monitored under this measure, and the resulting products for each species are summed to generate a total score.

Measure	Priority (H, M, L)	Detailed Description of the Data Source(s) and Protocols for How the Data Were Gathered
Natural Quality (contd)		
[2.3] Index of the status of select indigenous plant species	M	Wildlife Biologist, Annual Narrative Reports, Ottawa NWR Files - West Sister Island Wilderness Area, Status of Double-crested Cormorants in North America-Wires et al. 2001, Fact sheet: Monitored annually. Each species is classified by its population status and habitat threat with scores assigned by category. Scores are multiplied together for each species monitored under this measure, and the resulting products for each species are summed to generate a total score and reported in the Wilderness Character Monitoring Database.
[2.4] Index of status of species whose over-abundance threatens longevity of select indigenous nesting waterbird species on West Sister Island	H	Wildlife Biologist, Annual Narrative Reports, Ottawa NWR Files - West Sister Island Wilderness Area, Status of Double-crested Cormorants in North America-Wires et al. 2001: This measure monitors the population size, trends and habitat threat level for each species. The species population is recorded. The species is then classified by its population status and habitat threat with scores assigned by category. Scores are multiplied together for each species monitored under this measure, and the resulting products for each species are summed to generate a total score for the entire wilderness. This sum is reported in the Wilderness Character Monitoring Database.
[2.5] Ozone air pollution	L	NWRS, Center for Inventory and Monitoring (Fort Collins, CO): Data gathered at National level - the 2012 baseline value is presented as a 5-year average for years 2005-2009; since monitors are not in close proximity to West Sister Island Wilderness, values have been interpolated between monitors. Therefore, a trend for the natural quality is not assessed.
[2.6] Total nitrogen wet deposition	L	NWRS, Center for Inventory and Monitoring (Fort Collins, CO): Data gathered at National level - the 2012 baseline value is presented as a 5-year average for years 2005-2009; since monitors are not in close proximity to West Sister Island Wilderness, values have been interpolated between monitors. Therefore, a trend for the natural quality is not assessed.
[2.7] Total sulfur wet deposition	L	NWRS, Center for Inventory and Monitoring (Fort Collins, CO): Data gathered at National level - the 2012 baseline value is presented as a 5-year average for years 2005-2009; since monitors are not in close proximity to West Sister Island Wilderness, values have been interpolated between monitors. Therefore, a trend for the natural quality is not assessed.

Measure	Priority (H, M, L)	Detailed Description of the Data Source(s) and Protocols for How the Data Were Gathered
Natural Quality (contd)		
[2.8] Visibility	L	NWRS, Center for Inventory and Monitoring (Fort Collins, CO): Data gathered at National level - the 2012 baseline value is presented as a 5-year average for years 2005-2009; since monitors are not in close proximity to West Sister Island Wilderness, values have been interpolated between monitors. Therefore, a trend for the natural quality is not assessed.
[2.9] Change in mean annual temperature of wilderness	M	NOAA/National Climatic Data Center- National Climatological Monthly Data Reports (http://www.7.nchc.noaa.gov/IPS/cd/cd.html): The Toledo Express WSO AP provides Regional NCDC climate trends since there isn't a weather station in close proximity to West Sister Island. The MAT is calculated by recording the mean annual temperature at 5-year intervals (the average temperature for every year in 5-year intervals). The MAT is obtained by adding the Mean Daily Maximum for the month plus the Mean Daily Minimum for the month and then dividing that number by 2, (deriving the monthly average). These values are calculated for each annual report for the monitoring period (i.e., 2007-2011) and then the MAT is calculated for the recording period by dividing the sum of the monthly averages by 12 (deriving the annual average); the annual average is divided by number of years (i.e., 5). The value is calculated using annual temperature totals of the five years previous to the reporting year.
[2.10] Change in annual amount of precipitation on wilderness island	M	NOAA/National Climatic Data Center- National Climatological Monthly Data Reports (http://www.7.nchc.noaa.gov/IPS/cd/cd.html): The Toledo Express WSO AP provides Regional NCDC climate trends since there isn't a weather station in close proximity to West Sister Island. The average precipitation within wilderness is calculated by recording the total inches of precipitation at 5-year intervals (the total precipitation [in inches] for every year in 5-year intervals) and then dividing the total number of inches by the sample period. The average amount of precipitation is obtained by summing the annual monthly Total (in.) of Precipitation, divided by 12 to derive the average annual total; the average annual total is then dividing by number of total years of the monitoring period (i.e., 5) for each annual report of the monitoring period (i.e., 2007-2011). The value is calculated using annual precipitation totals of the five years previous to the reporting year.

Measure	Priority (H, M, L)	Detailed Description of the Data Source(s) and Protocols for How the Data Were Gathered
Undeveloped Quality		
[3.1] Number of signs within wilderness boundary	L	Wildlife Biologist, Assistant Refuge Manager, Wilderness Management Plan: An estimate of each sign type in wilderness Is provided. The sign type, location and number of each type are noted, but only a count of the total estimated number of signs is reported in the Wilderness Character Monitoring Database.
[3.2] Number of inholdings within wilderness	L	Refuge Manager, Wildlife Biologist, USFWS Realty Files-West Sister Island Wilderness, Wilderness Management Plan: This measure is a reporting of the number of inholdings found within the wilderness boundary. There are no inholdings within the wilderness boundary.
[3.3] Index of administrative mechanical transport, motorized equipment, and motor vehicle use in wilderness	L	Refuge Biologist, Refuge Manager: This measure tracks the status and trends of all motorized and mechanized use authorized by the refuge staff in the wilderness. An inherent weighting system has been assigned to each equipment type based on its perceived level of impact to social and biophysical resources. Impact levels: "low" is a mechanical use that causes a small impact to the social environment and little or no impact to the biophysical environment (i.e., hand-held motorized equipment, battery power tool, or wheelbarrow); "moderate" is a mechanized use that causes a large impact to the social environment (i.e., chainsaw, generator); "high" is a mechanized use that causes a large impact to the social environment and biophysical environment (i.e., helicopter). A total use level value is calculated for each motorized/mechanized use by multiplying the inherent weight of each type of equipment by the amount of actual use. The resulting products for each motorized/mechanized use are summed to generate a total score for the entire wilderness. This sum is reported to the Wilderness Character Monitoring Database.

Measure	Priority (H, M, L)	Detailed Description of the Data Source(s) and Protocols for How the Data Were Gathered
Solitude or Primitive and Unconfined Quality		
[4.1] Index of number of groups (Researchers and Refuge Staff) visiting wilderness	M	Wildlife Biologist, Special Use Permits, Biological Staff, Refuge Manager, Wilderness Management Plan: This measure is a reporting of the number of groups visiting the wilderness island. The management activity is recorded. The number of boats to transport each management type group and the number of visits are recorded. Scores are multiplied for each management type group under this measure, and the resulting products for each group are summed to generate a total score for the entire wilderness. The total number of groups visiting the wilderness annually is reported in the Wilderness Character Monitoring Database.
[4.2] Index of the degree of accumulated trash and debris on the wilderness island	M	Assistant Refuge Manager, Biological Staff, Wilderness Management Plan: This measure provides an index of the degree debris and litter present. Degree of litter indexed value scores are recorded as : 1 = Very Low (only small pieces of litter in very few locations); 2 = Low (some evidence of small debris at several locations); 3 = Moderate (some larger pieces of debris are accumulating along with several to many small pieces of litter); 4 = High (many pieces of larger debris and many pieces of small litter have accumulated); 5 = Very High (the debris and litter has accumulated to a much higher level than previously stated). Scores throughout the year are summed to generate a total score for the entire wilderness. The sum is reported in the Wilderness Character Monitoring Database.
[4.3] Number of Agency provided recreation facilities	L	Wildlife Biologist, CCP: This measure tracks the trends in permanent facilities that are used primarily for recreational purposes, regardless of whether they are for resource protection or visitor convenience. Data collected for this measure are from numerical counts of the number of physical installations including any unit or object created, set in place, erected, built, or positioned by U.S. Fish and Wildlife within wilderness.
[4.4] Number of restrictions on visitor behavior	L	CCP, Ottawa NWR Files - West Sister Island Wilderness Area, Refuge Manager, Wildlife Biologist, Fact Sheet, Wilderness Management Plan: Monitored annually. This measure is a simple count of the number of restrictions that the agency places on visitor behavior inside the wilderness. Since the entire island is closed to the public, the sole restriction is counted and reported.

APPENDIX C – Effort Required for Wilderness Character Monitoring

Effort Per Measure (WCM Biologist)

Quality	Indicator	Measure	Were data gathered from office paper files, computer files, or field work, professional judgment?	Time you spent gathering data for each measure (in whole hours)
Untrammeled	Authorized actions	Index of double-crested cormorant management actions conducted by staff/authorized agents	paper and computer files	3
Untrammeled	Authorized actions	Number of authorized research, survey, and monitoring projects that manipulate plants or wildlife habitat per year.	paper and computer files	1
Untrammeled	Authorized actions	Number of permitted special uses that manipulate the biophysical environment	paper files	1
Untrammeled	Unauthorized actions	Number of known incidents of unauthorized actions that influence the biotic and/or abiotic community inside wilderness	professional judgment	1
Natural	Plant and animal species	Presence of largest breeding colonial waterbird species on wilderness island	computer files	2
Natural	Plant and animal species	Index of status of select indigenous nesting waterbird species	computer files	2
Natural	Plant and animal species	Index of the status of select indigenous plant species	professional judgment	1
Natural	Plant and animal species	Index of status of double-crested cormorants whose over-abundance threatens longevity of select indigenous nesting waterbird species on West Sister Island	computer files, professional judgment	2
Natural	Physical resources	Ozone air pollution	I&M	NA

Quality	Indicator	Measure	Were data gathered from office paper files, computer files, or field work, professional judgment?	Time you spent gathering data for each measure (in whole hours)
Natural	Physical resources	Total nitrogen wet deposition	I&M	NA
Natural	Physical resources	Total sulfur wet deposition	I&M	NA
Natural	Physical resources	Visibility	I&M	NA
Natural	Biophysical processes	Change in mean annual temperature of wilderness	NOAA-NCDC	2
Natural	Biophysical processes	Change in annual amount of precipitation on wilderness island	NOAA-NCDC	2
Undeveloped	Non-recreational structures, installations, and developments	Number of signs within wilderness boundary	professional judgment	1
Undeveloped	Inholdings	Number of inholdings within wilderness	paper files	1
Undeveloped	Use of motorized or mechanical	Index of administrative mechanical transport and motorized equipment use in wilderness	professional judgment	2
Solitude +	Remoteness from inside	Index of number of groups (Researchers and Refuge Staff) visiting wilderness	computer files, professional judgment	1
Solitude +	Remoteness from outside	Index of the degree of accumulated trash and debris on the wilderness island	professional judgment	1
Solitude +	Facilities that decrease self-reliant recreation	Number of Agency provided recreation facilities	paper files	1

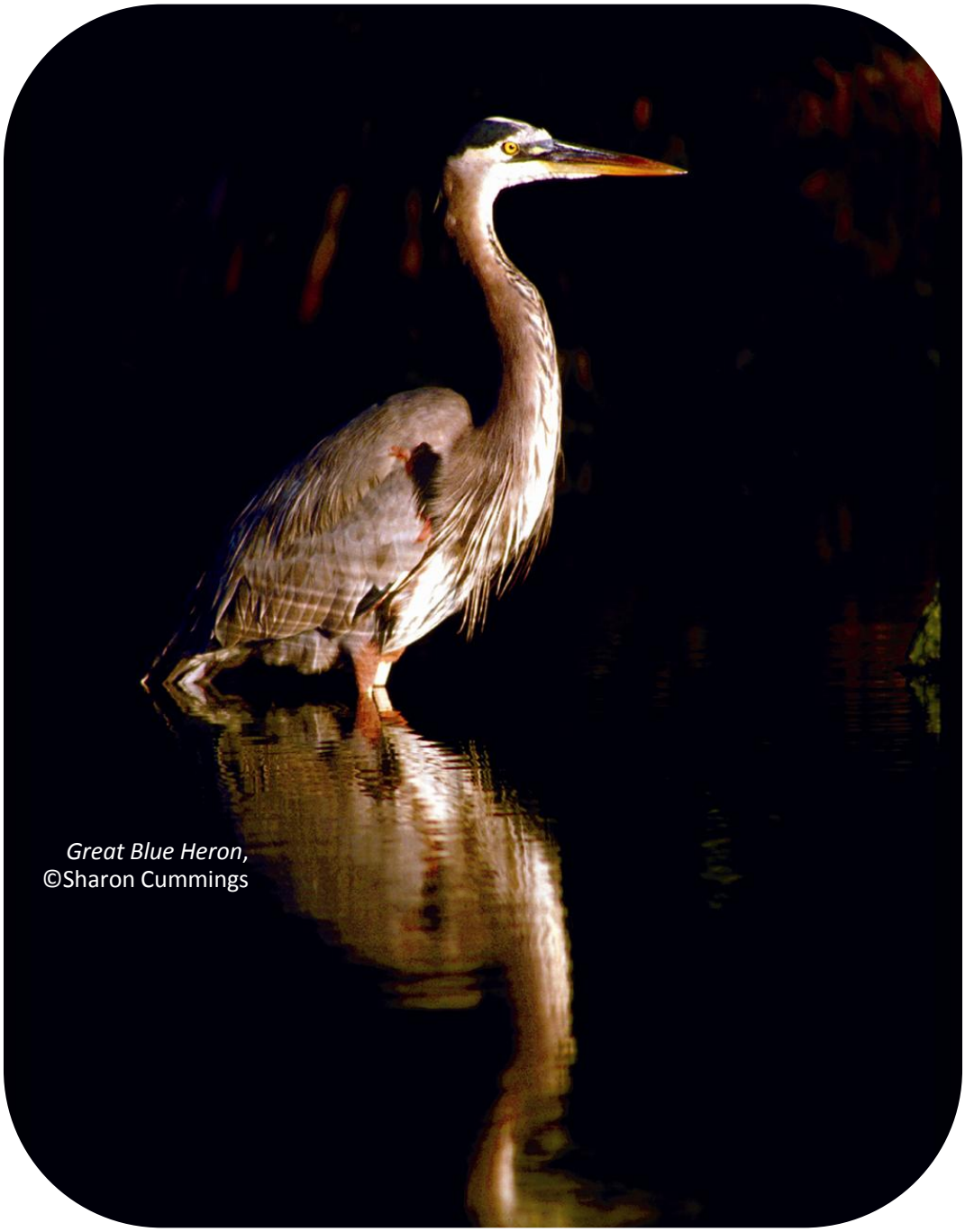
Quality	Indicator	Measure	Were data gathered from office paper files, computer files, or field work, professional judgment?	Time you spent gathering data for each measure (in whole hours)
Solitude +	Mgmt. restrictions on visitor behavior	Number of restrictions on visitor behavior	paper files	1
Other Features	Loss of cultural resources	NA		

Effort by Refuge

Title of staff involved in identifying, prioritizing, and selecting measures	Staff time to identify, prioritize, and select measures (in whole hrs.)	Comments
Wildlife Biologist	40	
Refuge Manager	8	
Asst. Refuge Manager	2	
Wildlife Biologist (Horicon NWR)	20	

Effort by WCM Biologist

Time you spent to identify, prioritize, and select all the measures (in whole hours)	Time you spent to learn how to enter data into the WCM database application (in whole hours)	Time you spent to enter all data into the WCM database application (in whole hours)	Time you spent on other tasks directly related to WCM (e.g., reading CCP, giving presentations, talking with staff) (in whole hours)	Time you spent doing other Refuge tasks not directly related to WCM (in whole hours)
120	10	25	130	0



Great Blue Heron,
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